POOR LEGIBILITY

ONE OR MORE PAGES IN THIS DOCUMENT ARE DIFFICULT TO READ
DUE TO THE QUALITY OF THE ORIGINAL

RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECLARATION

I. SITE NAME AND LOCATION

Iron Mountain Mine (IMM)
Shasta County, California (approximately 9 miles northwest of Redding, California)

II. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial action for control of releases of hazardous substances from widespread area sources in the Slickrock Creek watershed at the Iron Mountain Mine Site. The selected interim remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based upon the Administrative Record for this Site.

The State of California concurs with the selected interim remedial action for the Slickrock Creek area source acid mine drainage (AMD) discharges at the Iron Mountain Mine Superfund Site.

III. ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

The Slickrock Creek area sources of AMD include the numerous waste piles on the mine property, disturbed areas related to mining activity, contaminated groundwater and interflow seepage, underground mine workings, and underground mineralization exposed through mining-induced hydrologic and physical changes. The general disturbances in this area of Slickrock Creek are shown in Photo Exhibit 1. The releases from these sources consist of highly acidic, heavy metal-bearing waters, termed acid mine drainage, or AMD. The heavy metals contained in the AMD from Slickrock Creek area sources include, among others, copper, cadmium, and zinc. The AMD contains acidity and concentrations of copper, cadmium, and zinc that are toxic to aquatic life and harmful to humans. The response action will also address the hematite mine waste piles, which contain high levels of arsenic and are actively eroding into Slickrock Creek and thence to downstream areas.

The principal threat posed by these releases is the creation of conditions toxic to aquatic life in the receiving waters downstream of the Site. Surface water is the primary exposure pathway for discharges from the Slickrock Creek sources. The surface waters in the Spring Creek drainage affected by the Slickrock Creek area sources (Slickrock Creek, Spring Creek, and the Spring Creek Reservoir [SCR]) are essentially devoid of aquatic life as a result of releases of hazardous substances from the Site.

The SCR meters contaminated IMM AMD into the Sacramento River at Keswick Reservoir. The SCR, coupled with the prior CERCLA response actions implemented pursuant to the 1986 (ROD1) , 1992 (ROD2), and 1993 Records of Decision (ROD3), provides some degree of protection to aquatic resources and public health below the SCR, but IMM AMD discharges continue to harm and pose risks to aquatic resources in Keswick Reservoir and the Sacramento River (particularly during certain storm events when discharges from the Site are greatest), and to a significantly lesser degree, to public health. These discharges also fail to comply with CERCLA requirements. Even taking into account the response actions implemented to date (which have reduced sitewide releases by approximately 80 to 90 percent on average over the past several years), IMM AMD is expected to cause regular annual exceedances of protective water quality standards in Keswick Reservoir, continued exceedances in the Sacramento River under certain storm conditions, and the continued release of 25,000 to 70,000 pounds per year of copper and 40,000 to 90,000 pounds of zinc to Keswick Reservoir and the main stem of the Sacramento River in normal to wet water years. These discharges are approximately one to three times the metal load of all industrial discharges in the Sacramento River, Bay, and Delta combined.

Just below the point at which IMM AMD enters the Sacramento River, the Sacramento River supports a valuable fishery that includes four species of chinook salmon, steelhead, and resident trout. The winter-run chinook salmon has been designated as an endangered species under the federal Endangered Species Act, and at least one other species (the Sacramento River steelhead) is currently being considered for listing as endangered under that statute. The spring-run chinook salmon is currently a candidate species under the State Endangered Species Act. These species are particularly sensitive to toxic metals such as copper, cadmium, and zinc. The National Oceanic and Atmospheric Administration (NOAA) has identified the affected area as the most important salmon habitat in California.

Releases of hazardous substances from the site also pose a potential threat to human health. Concentrated AMD is harmful to humans. There is also a human health risk associated with consumption of fish contaminated by heavy metals from the site. The Sacramento River which receives releases of hazardous substances from the site serves as a source of drinking water for the City of Redding, although exceedances of drinking water criteria for metals and acidity due to site releases is expected to be rare. In addition, releases of arsenic from mine waste piles poses a potential threat to humans.

Through the performance of continuing remedial investigations and feasibility studies, the U.S. Environmental Protection Agency (EPA) has identified the control of the IMM area source AMD discharges from the Slickrock Creek and Boulder Creek watersheds as being necessary to meet remedial action objectives for the Site. Actual or threatened releases of AMD from both of these watersheds, if not addressed by implementing appropriate response actions, may present an imminent and substantial endangerment to human health or the environment. The response action selected in this Record of Decision (ROD4), however, only addresses the Slickrock Creek area source AMD discharges (which are estimated to account for approximately 60 to 70 percent of the copper load and 40 to 50 percent of the zinc and cadmium load associated with the currently uncontrolled Site discharges). The selected response action for the Slickrock Creek area source AMD discharges is expected to make significant progress toward abating the imminent and substantial endangerment to human health and the environment caused by the continuing AMD discharges from the IMM area sources. The EPA has determined that further study is warranted to support continued development and evaluation of remedial alternatives for the Boulder Creek area source AMD discharges. The EPA anticipates that an additional remedial investigation and feasibility study will be conducted to develop and evaluate control strategies for the area sources in Boulder Creek. The EPA also anticipates investigating the need to respond to other sources of mining-related hazardous substance releases from IMM, including but not limited to sediments deposited by past and current AMD releases.

IV. DESCRIPTION OF PRIOR REMEDIAL ACTIONS

The first ROD for the IMM Site (ROD1), signed in October 1986, provided for implementation of limited source control actions to begin lessening the IMM AMD discharges and also provided water management capability to manage the ongoing IMM AMD releases to surface waters. Specific activities authorized by ROD1 include a diversion of Slickrock Creek around contaminant-bearing landslide debris, diversion of Upper Spring Creek to the Flat Creek drainage, and a partial cap of Brick Flat Pit and seven subsidence areas. All of these projects have been completed. ROD1 also authorized the enlargement of the Spring Creek Debris Dam (SCDD) and the diversion of the South Fork of Spring Creek (SFSC). These two water management projects were deferred by EPA to allow for additional evaluation.

Pursuant to Records of Decision signed by EPA in 1992 (ROD2) and 1993 (ROD3), essentially all AMD releases from the three largest sources of IMM AMD (the Richmond portal, the Lawson portal, and the Old/No. 8 Mine Seep) are treated at the IMM treatment plant. The EPA selected the high density sludge (HDS) treatment process to ensure the long-term reliability, effectiveness, and cost-effectiveness of IMM treatment and sludge disposal operations. The treatment residuals are disposed of onsite in the inactive open pit mine, Brick Flat Pit. The response actions implemented pursuant to these two RODs have significantly reduced the release of hazardous substances from the Site. For example, during the period from January 1995 through March 1995, treatment of the IMM AMD from these three underground mine workings reduced sitewide discharges of copper, zinc, and cadmium by approximately 80 to 90 percent.

V. EPA's JUNE 1994 PROPOSED PLAN

In a Proposed Plan issued in June 1994, EPA proposed to enlarge the SCDD to establish a 15,000-acre-foot reservoir and to defer implementation of the SFSC diversion. Enlargement of the SCDD and construction of the SFSC were both components of the 1986 ROD. The 1986 ROD had deferred sizing of the reservoir. At the of the June 1994 Proposed Plan, it was EPA's assessment that source control and treatment alternatives were not available that could provide sufficient control of the IMM area source AMD discharges to meet remedial action objectives for the Site. The EPA had determined that the proposed enlargement of the

SCDD would provide sufficient water management capability to meet certain remedial action objectives for the Site, considering the extent of technical practicability limitations. The EPA received comments during the public comment period that identified additional source control and treatment alternatives for the IMM area source AMD discharges. The comments supported the technical feasibility of the source control and treatment approaches. Commenters also stated a preference for source control and treatment approaches over water management remedial alternatives. Taking into account these comments, the EPA deferred remedy selection and performed further studies of the suggested source control and treatment alternatives.

VI. DESCRIPTION OF THE SELECTED REMEDY

The selected interim remedial action is the fourth ROD for the IMM Superfund cleanup action. It focuses on the Slickrock Creek area source AMD discharges. The selected remedy, which is the same remedy EPA proposed in its May 1996 Proposed Plan, was largely derived from an alternative developed by a potentially responsible party and submitted to EPA during the public comment period on the 1994 Proposed Plan. The selected remedy addresses the principal threat posed by contaminant releases from area sources within the Slickrock Creek watershed at the IMM Site through collection, conveyance, and treatment of all of the flows in the most contaminated reach of Slickrock Creek, located directly downstream of the most heavily disturbed mining area in the basin. The selected remedy will involve constructing a dam to establish a small reservoir in Slickrock Creek to collect and contain the contaminated runoff for controlled conveyance to an expanded IMM HDS treatment plant. The selected remedy also involves constructing a surface water diversion to keep relatively uncontaminated surface water from flowing into the reservoir. The diversion will minimize the amount of water that requires treatment and the size of the dam required to ensure adequate storage capacity of the containment reservoir. New and modified pipelines will convey the contaminated water from the reservoir to the treatment plant. Necessary modifications to the IMM HDS treatment plant will be constructed. A conceptual depiction of the remedy is shown in Photo Exhibit 2.

The major components of the selected remedy include:

- Construct a retention dam and necessary surface water diversion facilities to ensure the collection and storage of contaminated surface runoff, interflow, and groundwater in the Slickrock Creek watershed at IMM.

- Construct facilities to provide controlled release of contaminated waters from the retention dam to the AMD conveyance pipeline to the IMM HDS/ASM lime neutralization treatment plant.

- Construct facilities to divert relatively uncontaminated surface water from the area upstream from the highly disturbed mining area of the Slickrock Creek basin and divert that water around the Slickrock Creek retention reservoir. The diversion shall also divert around the retention reservoir the water from the unmined side of the Slickrock Creek watershed.

- Take appropriate steps (including consideration of emergency failure scenarios) to integrate into the operation of the reservoir the collection and conveyance of the Old/No. 8 Mine Seep AMD to the IMM HDS/ASM lime neutralization treatment plant.

- Construct a hematite erosion control structure consistent with California mining waste requirements.

- Construct one or more sedimentation basin(s) or other EPA approved control structures in the Slickrock Creek watershed to minimize sedimentation of the Slickrock Creek retention reservoir and to ensure proper functioning of the controlled release facilities.

- Upgrade the hydraulic capacity of the existing pipeline (or if necessary construct a new pipeline) from Slickrock Creek to the Boulder Creek crossing as required to ensure adequate reliable capacity to convey Slickrock Creek and Old/No. 8 Mine Seep AMD.

- Construct an additional pipeline to reliably convey Slickrock Creek and Old/No. 8 Mine Seep AMD from the Boulder Creek Crossing to the IMM HDS/ASM lime neutralization treatment plant.

- Modify the IMM HDS/ASM lime neutralization treatment plant to ensure proper treatment, using the HDS/ASM treatment process, of the Slickrock Creek area source AMD discharges in conjunction with AMD flows collected pursuant to other Records of Decision.

- Construct a tunnel to provide for gravity discharge of the high volumes of effluent from the IMM HDS/ASM treatment plant to Spring Creek below the Upper Spring Creek diversion to Flat Creek.

- Construct facilities to assure collection of significant identified sources (including but not limited to seeps from Brick Flat Pit and the hematite piles) and convey those releases to the Slickrock Creek Retention Reservoir.

- Perform long-term operations and maintenance (O&M) of all components.

VII. STATUTORY DETERMINATIONS

Protective of Human Health and the Environment

With respect to the releases of hazardous substances that will be addressed by this interim action, this selected interim remedy is protective of human health and the environment. The selected interim remedy essentially eliminates the potential exposure and the resultant threats to human health and the environment from the Slickrock Creek area sources and the AMD discharge pathways addressed in this interim remedy. While the interim remedy is expected to essentially eliminate the risk posed by certain releases of hazardous substances from the facility, the interim remedy responds to only a subset of the currently uncontrolled releases of hazardous substances being released from the facility. The EPA therefore anticipates that the remedy will not fully protect human health and the environment and that additional remedial action will be required to respond to releases of hazardous substances from the facility.

Compliance with ARARs

Except for those applicable or relevant and appropriate requirements (ARARs) that EPA is waiving for this interim remedy, the interim remedy will comply with all Federal and State ARARs.

The EPA is waiving compliance with certain ARARs on the basis that this proposed action is an interim action that will not respond to all releases of hazardous substances from the facility. This interim action is not expected to provide for compliance with all ARARs at all times because the dam and treat interim remedial action for the Slickrock Creek area source AMD discharges does not address releases other than area sources in the Slickrock Creek watershed above the containment structure to be constructed on Slickrock Creek, such as releases from area sources in the Boulder Creek watershed, the existing sediments in SCR and Keswick Reservoir, and the streambeds in the Spring Creek watershed.

Since the action selected in this ROD is an interim action that leaves some releases of hazardous substances unabated, EPA is relying on the ARARs waiver for "interim measures" (CERCLA § 121(d)(4)(A); 40 CFR § 300.430(f)(1)(ii)(C)(1)) for this remedial action. In particular, EPA anticipates that the remedy will improve water quality in Spring Creek, SCR, Keswick Reservoir, and the Sacramento River, but EPA does not anticipate that this remedy, in conjunction the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific standards contained in the State Basin Plan Standards (SBPS) for copper, cadmium, or zinc, and (2) California Fish and Game Code § 5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards for the interim action to the extent those standards cannot be achieved by the remedy selected in this ROD in conjunction with the remedies implemented under prior RODs. The EPA anticipates that completion of additional remedial actions will address compliance with these ARARs.

Cost-Effectiveness

The EPA has determined that the selected remedy is cost-effective pursuant to evaluations in accordance with § 300.430(f)(1)(ii)(D) of the NCP.

Permanent Solutions and Treatment Technologies

The EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized for the remedial action for the Slickrock Creek area source AMD discharges. This proposed remedy involves as its principal element the treatment of hazardous substance releases from the Slickrock Creek area sources upstream of the retention dam.

The remedy will not reduce the generation of hazardous substances in the same manner that a remedy that reduces or eliminates AMD-forming reactions (and thereby reduce the need for ongoing treatment operations). The EPA has concluded that source-specific control actions may be available for at least some of the Slickrock Creek area source AMD discharges. However, those control actions are not currently implementable, effective, or cost-effective in comparison to the selected dam and treat remedial action. While current technology and knowledge are not sufficient to permit implementation of reliable source-specific controls for the Slickrock Creek area sources, EPA encourages the continued development of those alternatives that could reduce or eliminate the AMD-forming reactions. The EPA will continue to consider subsequent action for the IMM Site that could supplant the need to perform long-term treatment of the area source AMD discharges.

Consistency with Final Remedy

This action of selecting a remedial alternative that addresses Slickrock Creek without first requiring completion of the studies for Boulder Creek is consistent with 40 CFR § 300.430 (a)(ii)(A), which identifies as a program management principle that "[s]ites should generally be remediated in operable units when necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size and complexity of the Site, or to expedite the completion of total Site cleanup." The investigations conducted by the EPA to date, including an intensive peer review of control options, indicate that technically practicable and cost-effective remedies are available to remediate releases of hazardous substances from Boulder Creek area sources and from sediments in and below SCR.

This action does not constitute the final remedy for the IMM Site. Additional response actions will further address the statutory preference for remedies employing treatment that reduces toxicity, mobility, or volume as a principal element. Subsequent actions are planned to fully address the threats posed by the conditions at the facility. This remedy will result in hazardous substances remaining onsite above health-based levels, so within 5 years after commencement of the remedial action, EPA will conduct a review to ensure that the remedy continues to provide adequate protection of human health and the environment. This is an interim action ROD, so review of this facility and of this remedy will be ongoing as EPA continues to develop final remedial alternatives for the Site.

Keith A. Takata   9-30-97

Keith A. Takata, Director
Superfund Division
U.S. Environmental Protection Agency

Date

RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

I.1 Site Name

Iron Mountain is located in Shasta County, California, approximately 9 miles northwest of the City of Redding (Figure 1). The collection of mines on Iron Mountain is known as Iron Mountain Mines. The Iron Mountain Mines are the southernmost mines in the West Shasta Mining District. The District encompasses more than a dozen sulfide mines that have been worked for silver, gold, copper, zinc, and pyrite.

I.2 Site Location

The Iron Mountain Mine (IMM) Superfund Site is defined pursuant to CERCLA to include the inactive mines on Iron Mountain and areas where hazardous substances released from the mines are now located. The IMM Site contains approximately 4,400 acres of land that includes the mining property on Iron Mountain; the several inactive underground and open pit mines; numerous waste piles; abandoned mining facilities; mine drainage treatment facilities; the downstream reaches of Boulder Creek, Slickrock Creek, Flat Creek, and Spring Creek; Spring Creek Reservoir (SCR); Keswick Reservoir (which includes both the Spring Creek arm of the Keswick Reservoir and the main body of Keswick Reservoir); and the Sacramento River affected by drainage from IMM.

I.3 Site Description

The summit of Iron Mountain is 3,583 feet above mean sea level and is approximately 3,000 feet above the Sacramento River, 3 miles to the east. The terrain is very steep, with slopes dropping 1 to 2 feet for every 2 feet horizontally, or steeper. The mountain is predominantly forested with areas of brush, and there are numerous unpaved roads leading to the various work locations.

Several, and possibly all, of the mines and the waste rock piles are discharging acidic waters, typically with a high content of heavy metals. These discharges are herein referred to collectively as acid mine drainage, or AMD. The largest sources of AMD are located within the IMM property. The largest source of AMD is the Richmond Mine, and the second largest is the Hornet Mine. Both of these sources drain into Boulder Creek. The third largest source, Old/No. 8 Mine Seep, drains into Slickrock Creek. From 1988 to 1994 a portion of these sources were treated at an emergency treatment plant. Starting in 1994, essentially all of

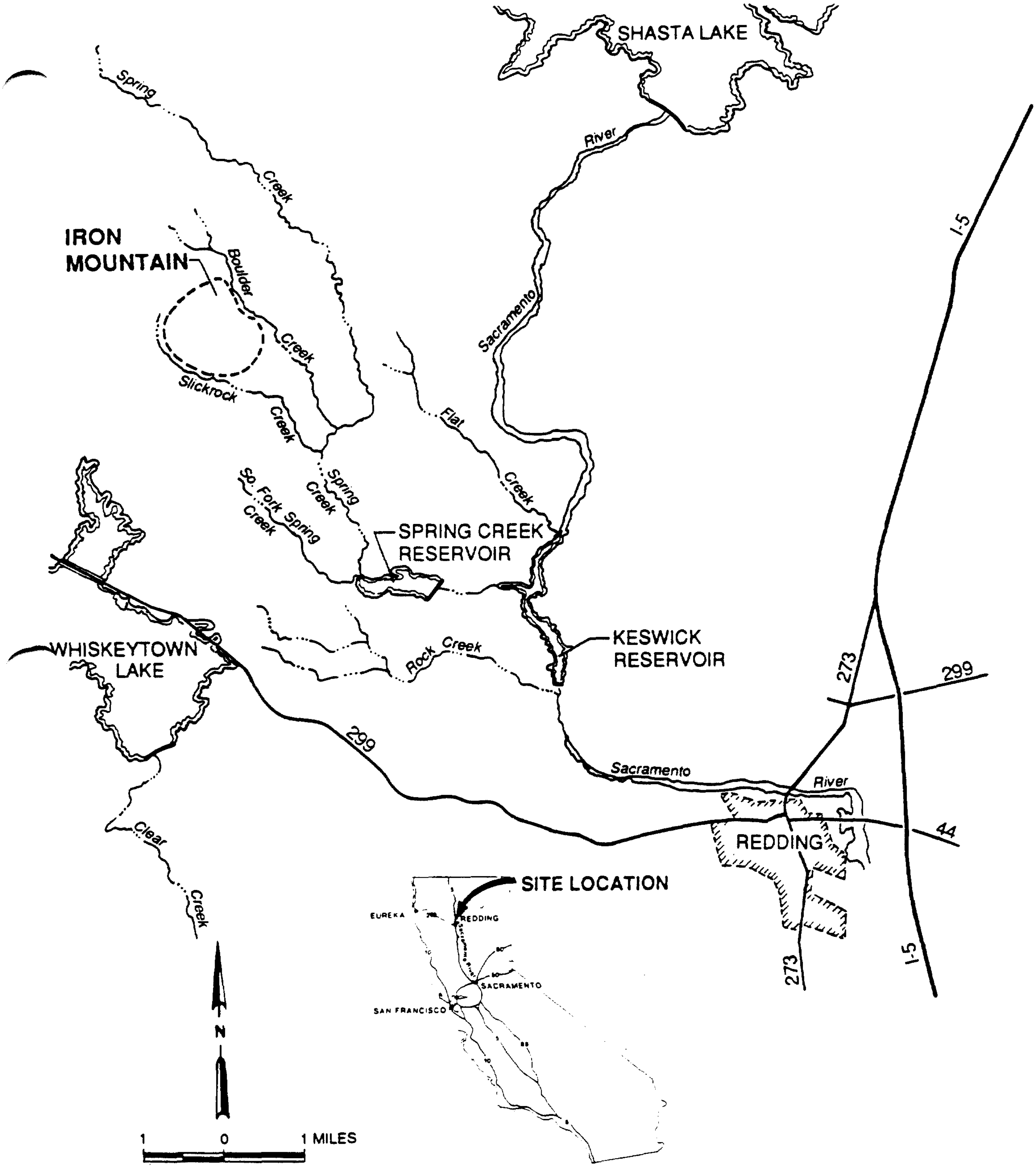


FIGURE 1
LOCATION OF
IRON MOUNTAIN SITE
IRON MOUNTAIN MINE

these sources have been treated at the IMM treatment plant constructed onsite at Minnesota Flats. From 1994 to 1996 the AMD was treated using the simple mix treatment method. Since January 1997, the HDS treatment system has provided an improved means of treating these discharges.

These remedies have been highly effective in reducing the release of metals from the site. Over the past several years, the treatment of selected AMD flows from IMM has reduced the release of copper, cadmium, and zinc by approximately 80 to 90 percent.

The remaining discharges derive from widely dispersed area sources associated with past mining activities. The IMM area sources include waste piles; sidecast spoils; ground disturbed by mining-related activities; mineralization exposed by mining-induced water table depressions and other hydraulic changes induced by mining; discharges from buried workings or partially accessible workings; contaminated soil and debris; mining-caused seeps; contaminated interflow and groundwater; and contaminated sediments in the Slickrock Creek, Boulder Creek, and Spring Creek watersheds at IMM. This ROD addresses area sources in the Slickrock Creek watershed, which account for approximately 60 to 70 percent of the uncontrolled copper loads, and 40 to 50 percent of the uncontrolled zinc and cadmium loads currently being generated at IMM. The discharges from these sources are closely associated with heavy rainfall and high runoff storm events.

The fishery resources and other sensitive aquatic species in Keswick Reservoir and in the Sacramento River below Keswick Dam are the primary natural resources at risk to the continuing uncontrolled IMM heavy metal discharges from the Site. The exceedance of water quality standards and the accumulation of toxic sediments downstream of IMM contribute to the risks to species in the areas impacted by IMM releases. As a result of past mining activities and current IMM AMD releases, the affected water bodies upstream of the Spring Creek Debris Dam (SCDD) are essentially devoid of aquatic life and amphibians, which are dependent upon that aquatic life. The releases also pose a potential threat to human health.

I.4 Adjacent Land Uses

The adjacent land is largely undeveloped wilderness property that is currently infrequently visited because of the rugged topography and scarcity of roads. Off-road vehicles have been known to visit these areas, and the U.S. Bureau of Land Management (BLM) has notified EPA with regard to potential acquisition of adjacent lands for preservation as wilderness and enhancement for recreational use.

I.5 Natural Resources Uses

The natural resources on the mining property and in the surface waters which flow on or adjacent to the mining property at one time included mature stands of timber, fish, other aquatic populations, and sulfide minerals. The IMM Site contains one very large mass of nearly pure sulfide, several small sulfide deposits, several zones of disseminated sulfides, and a large gossan. The mineral deposits are contained in a rhyolite bedrock. The gossan is a rock zone from which sulfides have been almost completely removed by natural solution, leaving a residue of iron and other metals. The gossan has been mined by open pit for residual metals. The sulfide deposits have been mined in open pit and underground openings for copper, cadmium, zinc, and pyrite. Commercial mining at the IMM Site started in 1879 and continued with few interruptions until 1963. In the early twentieth century, the Site was one of the largest copper mines in the United States. At that time, mineral extraction objectives and methods varied widely at the Site. In recent years metal recovery activity at the Site has been limited to extracting copper from the AMD using copper cementation.

The valuable natural resources in the downgradient Sacramento River include the Sacramento River fishery, recreational use of the river and the Keswick Reservoir, and the water resource itself, which is a major component of the U.S. Bureau of Reclamation's (USBR's) water distribution system in California.

The portions of Boulder Creek, Slickrock Creek, and Spring Creek impacted by IMM AMD are essentially lifeless. Spring Creek Reservoir was constructed in part as a mitigation measure for the AMD discharges and does not support aquatic life, nor is it currently used for any recreational purpose. The portion of Keswick Reservoir affected by IMM AMD has reduced recreational value. The resident trout fishery in Keswick Reservoir and the main body of the Sacramento River is impacted by both the heavy metal contaminants in the water column of the mixing zones and the heavy sediment loading caused by the precipitation of iron and other heavy metals discharged from IMM over the past century.

The upper Sacramento River salmon fishery is the most important fishery in the State of California. The salmon fishery has experienced large population declines because of a number of factors, including the IMM AMD impacts. The Sacramento River also supports a major steelhead trout and resident trout fishery.

The IMM AMD discharges impact the beneficial uses of the Central Valley Project (CVP) water resources. The CVP is a central component of the California water distribution system. Shasta Lake, which is above the influence of IMM, plays an important role in California's water distribution system for California's municipal and agricultural interests. The high metal loads from IMM require large volumes of dilution water to dilute the pollution to levels that are safe for the affected resources. The large pollution loads generated at IMM have required emergency releases of clean water from Shasta Lake to dilute the IMM AMD. For example, in 1992 the USBR released more than 92,000 acre-feet of water during the sixth year of a drought to dilute a spill of IMM-contaminated waters. This amount of water is sufficient to supply the water demand for 360,000 people for one full year.

Currently, the SCR is relied on to meter the Spring Creek watershed surface waters, contaminated by the continuing uncontrolled IMM AMD area source discharges, into the Sacramento River at Keswick Reservoir. The SCR, coupled with the prior CERCLA response actions implemented pursuant to ROD1, ROD2, and ROD3, provides some degree of protection to aquatic resources and public health below the SCR, but IMM AMD discharges continue to harm and pose risks to aquatic resources and human health in Keswick Reservoir and the Sacramento River (particularly during certain storm events when discharges from the Site are greatest). Under certain conditions, the intense hydrology of the Spring Creek watershed and the highly polluted IMM AMD overwhelm the ability of the SCR to contain releases until they can be safely diluted. When the SCR is full, IMM AMD spills uncontrollably into Keswick Reservoir and the Sacramento River.

The SCR is currently operated to target certain interim metal levels below Keswick Dam. These operational targets approximate but do not equal the SBPS. If the SCR were operated to target compliance with a more stringent standard such as the SBPS or the Proposed California Toxics Rule (PCTR), water would be metered at a slower rate from the SCR, which in turn would cause the reservoir to fill and spill more frequently. Under current conditions, uncontrolled SCDD spills are expected to occur on average every 3 to 4 years if the SCDD is operated to achieve the SBPS below Keswick Dam. Operating the SCDD to meet the recently proposed PCTR (below Keswick Dam) would cause the spills to occur ever 2 to 3 years on average. Spills would occur even more frequently if the SCR were operated to target compliance with these standards in Keswick Reservoir rather than downstream of Keswick Dam. Even during non-spill periods, metal levels in the part of Keswick Reservoir closest to the SCDD are toxic to aquatic life for much of the year and many miles of creek above the SCDD are completely devoid of life as a result releases from the site. The frequency of SCDD spills can be reduced by reducing metal loads to SCR (by controlling pollution at Iron Mountain). The lower metal loads to SCR will permit the IMM AMD to be evacuated from the SCDD at a faster rate, which in turn would decrease the frequency of SCDD spills and exceedances of water quality criteria.

A major portion of the sulfide minerals remains in the mines and in undeveloped areas. The market for sulfide minerals has not been attractive in recent years, and there is no verified proposal to mine these deposits in the near future.

The timber that remains at IMM is not a valuable resource. The timber has either been removed for the mine operations or sale or it was extensively damaged by smelter operations in the early 1900s.

I.6 Location of and Distance from Human Populations

Iron Mountain Mine is relatively remote from human populations because of the rugged terrain and the single-access roadway. The City of Redding has a population of approximately 70,000 people and is located approximately 9 miles from the Site. The closest community is Keswick, located just east of the Site. There are several isolated residences between Keswick and the mine property. The EPA has provided metal gates, which are locked at most times, to discourage casual entry to the Site. Currently, human contact with surface waters impacted by IMM contaminant discharges is mainly limited to areas downstream of the SCDD, which include Keswick Reservoir and the Sacramento River below Keswick Dam.

I.7 General Surface-Water and Groundwater Resources

Iron Mountain Mine surface drainage includes Boulder Creek, located northeast of the mountain, and Slickrock Creek, located to the southwest. Boulder Creek and Slickrock Creek flow into Spring Creek, which flows south and east to the SCR. The USBR releases flow into the Sacramento River from the SCR. Flat Creek drains an area to the east of Iron Mountain and enters the Sacramento River approximately 0.8 mile north of Spring Creek. As a result of a water diversion project constructed in 1990 as part of the CERCLA response at Iron Mountain, Flat Creek also receives water from Upper Spring Creek.

Slickrock Creek drains the south side of Iron Mountain and flows generally from the northwest to the southeast. The headwaters of Slickrock Creek are at about Elevation 3200 feet.

The creek flows about 3 miles to its confluence with Spring Creek at Elevation 1350. The stream carries water from several small ephemeral tributaries as well as discharges from Old/No. 8 Mine Seep and Big Seep, 200 to 300 feet upstream. Slickrock Creek also receives drainage from Brick Flat Pit. The average daily flow of Slickrock Creek at its confluence with Spring Creek is 9.4 cubic feet per second (cfs) (4,200 gallons per minute [gpm]).

The rainfall-runoff varies significantly between and during storm events. The amount of runoff is dependent on antecedent moisture conditions, storm intensity, the vegetative cover, ground slope, length of distributing area, and geology. Major storm events produce a rapid rise in water levels in the creeks.

The rhyolite rock that makes up IMM is very dense, with two to three sets of joints and a number of faults. The rock mass lacks significant porosity because of joint/fault discontinuities. The sulfide mass deposits were largely isolated from the groundwater before mining because the joints generally do not extend from the rhyolitic rock into the mineralized zone. Groundwater was present in the disseminated sulfide zones. Mine openings and fracturing caused by ground movements induced by mining have created access routes for the groundwater to the large volumes of massive sulfide deposits and have increased groundwater access to the disseminated sulfide mineralization. The additional groundwater movement and increased circulation of air within the mountain has greatly accelerated the process of sulfide dissolution and the formation of metal-rich acid mine drainage.

Surface water and groundwater at Iron Mountain were previously used for mining operations and to provide water supply to the mine staff and their families. These resources are essentially unused today because the mines are inactive and surface waters are being contaminated by AMD.

I.8 Surface and Subsurface Features

The largest sulfide ore mines on Iron Mountain include an open pit mine at Brick Flat, underground workings at Old Mine, No. 8 Mine, the Confidence-Complex Mine on the southern flank of the mountain, and the Richmond and Hornet Mines on the northern flank. The Slickrock Creek drainage mines include the Old Mine, No. 8 Mine, Confidence Mine, and the Okosh Mine. The Old Mine and No. 8 Mine have had more significant mining operations and are considered more significant sources of AMD. The Okosh and Confidence Mines are considered to be less significant sources than the Old Mine and No. 8 mine but do discharge AMD during certain periods.

Old Mine was developed to mine portions of a gossan deposit which could not be reached by quarrying. The mine is under the north slope of Slickrock Creek Valley with the mine workings ranging from the elevation of the lower slope to well below the elevation of the adjacent reach of Slickrock Creek. Mining in the Old Mine relied upon a method of underground mining called slice stoping. The ore was removed in 7-foot-high layers working from the bottom toward the top of the deposit. A working surface was maintained by progressively backfilling the mined opening with rock rubble returned to the mine through dropholes from the ground surface. The extent of the backfilling is not clear from the records available, but the volume of remaining voids at the time of closure appears to have been small compared to adjacent mines. The backfilling operation was performed to support the working surface, was highly porous, and did not re-establish the pre-mining, undisturbed hydrologic conditions that would serve to reduce the rate of pyrite oxidation. In fact, the temperature of sulfides in the backfilled areas of the mine was so high, resulting from the ongoing oxidation reactions, that the sulfide minerals regularly caught on fire, presenting a severe safety hazard to miners.

The ore deposit of the No. 8 Mine is at the level of the middle of the north slope of Slickrock Creek Valley. The intervening 300 feet of rock has little or no sulfide mineralization. The ore is a mass of rock with disseminated chalcopyrite mineralization in veins. In contrast, the other mines on the IMM Site consist of massive sulfide or massive disseminated ore bodies. The No. 8 Mine consists of three levels of tunnels and small- to moderate-size openings which follow the veins. The mine is as high as Elevation 2400, but portions are below the elevation of Slickrock Creek. Mining started in 1907 and ended after World War II. Portions of the mine are reported to have been backfilled with waste rock or tailings slime. In order to support this effort to backfill the mine openings, the No. 8 Adit was plugged. Although the attempt to backfill the No. 8 Mine with gossan slimes was essentially unsuccessful, plugging the mine opening has resulted in the flooding of the underground workings to a level approximately 100 feet above elevation of the No. 8 Adit. This discharge emerges from the massive Slickrock Creek debris slide as the Old/No. 8 Mine Seep. An estimated 1.7 million tons of ore was extracted from the Old and No. 8 Mines.

The Brick Flat open pit mine was operated between 1929 and 1942 for gossan and from 1955 to 1962 for pyrite. Approximately 500,000 tons of ore were extracted. Millions of tons of overburden containing low grade, disseminated mineralization were dumped into Slickrock Creek in the effort to expose the ore in Brick Flat Pit. Most of the overburden and waste rock was placed in a large waste pile south of the pit and above the north slope of Slickrock Creek Valley. In 1955, a large landslide of these materials moved into the Slickrock Creek Valley, covered the Old Mine and No. 8 Mine portals, and filled the valley bottom to a depth of 80 feet. A comparison of old and recent topographic maps indicates that the present bed of Slickrock Creek is about 40 feet south of the bed prior to the large, mining-induced slide. The slide surface is presently almost devoid of vegetation, suggesting continued sliding.

Significant portions of the gossan cap on Iron Mountain were mined to recover gold and silver in a heap leaching operation. Approximately 2.7 million tons of gossan were extracted, crushed, and processed for recovery of precious metals. The extraction of gossan ore required the excavation and wasting of significant amounts of overburden and low grade gossan, which were dumped on steep slopes of the Slickrock Creek watershed or in the creek itself behind tailings dams. The finely crushed wastes from the heap leaching operations were dumped into Hogtown Gulch, forming the enormous waste piles that today are called the hematite piles.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

II.1 History of Site Activities that Led to Current Problem

Iron Mountain Mine was first secured for mining purposes in 1865, and various individuals held the property and conducted limited mining for the recovery of silver from the gossan areas in the late 1800s. The waste-generating activities that created the surface sources of AMD likely began in the 1880s when the gossan was first mined on a large scale, and waste rock that was removed to reach the ore was apparently dumped into ravines and eventually washed into the creeks.

Beginning in late 1894, Mountain Mining Co., Ltd. (Mountain Copper), began operation of the mine. In approximately 1896, Mountain Copper assumed ownership of the mine. Under Mountain Copper, IMM became the largest producer of copper in California and the sixth largest producer in the country during the first quarter of the twentieth century. High-grade copper ore was mined in Old Mine until 1907, No. 8 mine from 1907 until as late as 1923, Hornet Mine from 1907 to 1926, the Richmond Mine from 1926 through 1956, and Brick Flat Pit from 1929 to 1942 and 1955 to 1962.

In 1967, Stauffer Chemical Co. (SCC) acquired Mountain Copper. In 1968, SCC obtained legal title to the properties comprising IMM from its wholly owned subsidiary, Mountain Copper Company, Ltd. SCC originally took steps to reopen the mine, but the price of sulfur dropped to a point that caused the option to be uneconomical. SCC operated the copper cementation plant on Boulder Creek during its ownership of the Site and continued to investigate the commercial mining potential of the property. In November 1976, the Central Valley Regional Water Quality Control Board (CVRWQCB) issued an order to SCC requiring the abatement of the continuing pollution from the mountain.

In December 1976, SCC transferred ownership of 31 parcels on Iron Mountain to Iron Mountain Mines, Inc. (IMMI), and in December 1980, SCC transferred five additional parcels to IMMI. IMMI, a California corporation, is the current owner of Iron Mountain, but SCC retained ownership of certain property interests at the Site. IMMI constructed a copper cementation plant on Slickrock Creek in 1977. IMMI has intermittently operated this plant and the copper cementation plant on Boulder Creek to recover copper from the AMD.

II.2 Impacts of Mining Activity at Iron Mountain

Mining activities have fundamentally altered the geochemical and hydrologic conditions at Iron Mountain. In an undisturbed condition, a series of geologic and geochemical factors combined to permit the several large masses of sulfide mineralization to remain in place below the water table over geologic time. Now that mining has altered those conditions, however, the massive mineralization is no longer protected by the water table from oxidation, which in turn has exposed the mineralization to conditions that permit the rapid (on a geologic time scale) oxidation and release of acidity and metals from that deposit. Although the mineral deposit was formed about 400 million years ago, mining has accelerated the rate of oxidation such that it will now take only about 3,000 years to deplete the entire deposit. These mining-induced changes are the source of the severe pollution problem at IMM.

When pyrite is exposed to moisture and an oxidant (such as free oxygen or an aqueous ferric iron), the pyrite oxidizes and releases acidity. This acidity mobilizes metals, such as copper, cadmium, and zinc, into solution. The overall driving force for this reaction is the accessibility of an oxidant, either in the form of free oxygen or some other oxidant such as aqueous ferric iron. The rate at which pyrite oxidizes is limited by the access of the pyrite to oxidants. The oxidation of pyrite produces an iron oxide material or gossan.

Prior to mining, a gossan cap and relatively impervious bedrock protected the fresh mineralization (i.e., unoxidized pyrite) from extensive oxidation. Although relatively small amounts of pyrite and metal exist within the weathered gossan on the surface, those materials did not generate appreciable amounts of heavy metals and acidity relative to current conditions. The undisturbed gossan provided a protective shell that limited the access of water and oxygen to the residual unoxidized pyrite and metals locked within the gossan.

The undisturbed gossan contained preferential flow paths that conveyed rainfall as runoff to the creeks. These flow paths would typically be highly weathered by exposure over geologic time. Since they were highly weathered, the flow paths would permit rainfall to move quickly through the gossan without becoming highly acidic. These preferential flow paths also channeled water along the surface so rainfall tended to not penetrate to deeper areas where unoxidized mineralization was present. Water traveling through highly weathered gossan therefore contains essentially no dissolved metals or acidity.

In the undisturbed condition, the fresh (i.e., unoxidized) mineralization at IMM was largely below the water table and therefore isolated from conditions (namely, both free oxygen and water) that permit the formation of highly acidic and metal-laden AMD. While limited oxidation occurred near the contact between the iron oxides of the gossan and the fresh massive sulfide, numerous factors combine to severely limit the flow through the area of oxidation as well as the rate of oxidation. In an undisturbed mineralized environment, the hydrology typically permits only a small fraction of the groundwater to contact the mineralization deep below the surface because, with depth, the ground tends to become less permeable and less fractured. When fractures do occur at depth in undisturbed mineralization, the fractures tend to be highly localized, which in turn restricts the flow of water and oxygen into and out of the fracture. Buildup of oxidation products (i.e. clays) within the area of oxidation would also act to limit the infiltration of fresh water to the zone, which would act to further restrict the flow in the area of oxidation. The steep topography at Iron Mountain further limits the introduction of groundwater because a greater portion of rainfall would be expected to run off rather than infiltrate the mountain. Furthermore, the water that does infiltrate will be subject to very high hydraulic gradients promoting groundwater flow to the creeks rather than to the relatively deep oxidation zone under natural conditions.

As groundwater infiltrates below the groundwater table and the zone of active oxidation, oxygen is depleted and the groundwater becomes reduced. In this reducing environment, soluble copper from the oxidized zone is immobilized as secondary copper sulfides. Since secondary sulfides retain at least some of the metals, metals are not entirely released from the massive sulfide to the groundwater entering Boulder and Slickrock Creeks.

Mining activities at Iron Mountain changed these conditions in profound ways. Mountain Copper employed stoping, block caving, and room-and-pillar mining techniques in the underground mines; side-hill and open-pit techniques were used at the ground surface. The extensive mine disturbance in the Slickrock Creek basin is shown in Photo Exhibit 1, located at the back of this Record of Decision. These mining activities and subsequent collapse of some of the underground mine workings have fractured the bedrock overlying the mines. The sulfides in the fractured bedrock above the mines and the sulfides remaining in the mines are, in the post-mining period, more exposed to water, air, and bacterial action. The potential for acid drainage and metals contamination is greater than prior to mining and, since the mining ceased, this potential may have increased in response to deterioration of the ground over the abandoned mines.

The engineered mine openings and the partially collapsed mineralized zones affected by mining activity now function as effective groundwater drains drawing groundwater and unsaturated percolation to and through the sulfide mineralization. Prior to mining, groundwater movement through this area would have been quite limited relative to current conditions. The increased flows through these unoxidized areas altered the rate of oxidation in these areas. Increased flows resulted in releases of acidity and metals above the levels that existed before the mining disturbance.

Mining also altered the release of metals and acidity by exposing sulfides that were once largely below the water table (and therefore not exposed to free oxygen or another oxidant) to conditions that permit the rapid oxidation and release of metals and acidity. Mining activities lowered the groundwater table through channeling groundwater through engineering mine workings, mine fractures, and other mine disturbances. The lowering of the groundwater table exposes fresh sulfides to free oxygen and water (where prior to mining these sulfides were not exposed to free oxygen because they were under water). The lowering of the groundwater table therefore increases the rate of oxidation and release of acidity and metals.

The increased oxidation of the sulfide elevates the overall temperature in the sulfide mineralized zone because the reaction is exothermic. The increased heat associated with these higher reaction rates induces convective airflow, and likely induces evaporation of some subsurface mine waters. These processes contribute to the intensity and pattern of acidic discharges.

Mining also increased the oxidation rate of gossan by fracturing, crushing, pulverizing and otherwise breaking the gossan, which in turn exposes the residual metals and pyrite within the gossan to greater flows of water and oxidants.

These mining-related characteristics, in combination with the occurrence of the highly concentrated massive sulfide deposits surrounded by bedrock with very little neutralizing capacity, result in a unique hydrogeochemical reactor that is nearly optimal for maximum production of acid mine waters. Iron Mountain produces runoff that is among the most acidic in the world, containing extremely elevated concentrations of copper, cadmium, zinc, and other metals known to be toxic to aquatic life and humans.

Mining has changed not only the pH and the concentration of heavy metals in the receiving waters, but also the pattern of release of hazardous substances. Prior to mining, the metal and acidity releases that did occur would have been diluted releases associated with surface runoff from the highly weathered surfaces of Iron Mountain and groundwater that would have not been exposed to highly reactive mineralization (because the elevated water table would submerge unreacted sulfides, excluding oxygen and inhibiting the oxidation reaction). In contrast, the post-mining discharges include surface runoff that percolates through enormous highly porous waste piles, disturbed soils, and surface mining areas; groundwater that percolates through fractured geologic systems in contact with highly reactive mineralization exposed by the depressed water table; and significant discharges of highly concentrated AMD issuing from the mine workings that results from inflow of near-surface waters deep into the fractured mineralized zones through conduits of collapsed and caved ground. These disturbances therefore create the intense peak metal discharges associated with high-flow events, in addition to the high metal loads associated with low-flow conditions.

The sources addressed by the action selected in this Record of Decision include the area sources in the Slickrock Creek watershed. These sources include waste piles, sidecast spoils, ground disturbed by mining-related activities, discharges from buried workings or partially accessible workings, mine-contaminated soil and debris, mining-related seeps, mining-contaminated interflow and groundwater, and mining-contaminated sediments in the Slickrock Creek watershed at IMM. These sources have clearly been altered by mining. Photo Exhibits 1 and 2 (located at the back of this Record of Decision) illustrate both the extent of mining disturbance in the area being remediated and the degree to which the response action is focused upon the most heavily disturbed portion of the Slickrock Creek basin. Among the sources being remediated, EPA is aware of no identifiable release or threat of release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found.

II.3 Central Valley Project-Related Impacts

The Sacramento River is a primary water resource for much of the State of California. As growth increased the demand for water, the importance of the Sacramento River has grown as well. The increasing demand for scarce water resources, coupled with a growing understanding of the sensitivity of aquatic resources to trace levels of toxic metals present in the Sacramento River as a result of past mining activities, has increased the significance of IMM AMD impacts in the Sacramento River.

In response to the growing demand for water and the need to control flood waters, the USBR constructed the Shasta Dam to control Sacramento River flows. USBR completed the Shasta Dam in 1943 and the Keswick Dam, located downstream of Shasta Dam, in 1950. Construction of the dams changed the conditions in the Sacramento River. Once USBR completed the Shasta and Keswick Dams in 1950, the salmon and steelhead were restricted to spawning grounds in areas downstream of Keswick Dam, which is one of the areas of the Sacramento River with the greatest exposure to AMD discharges from Iron Mountain (the other area being Keswick Reservoir). The dam also reduced the availability of dilution flows at certain times, which would tend to increase the metal concentrations in the river. While the Shasta and Keswick Dams changed the river system, toxicity problems are documented both before and after the completion of Shasta Dam in 1943. Only limited water quality information is available from the pre-Shasta period, but water quality modeling and the limited available data indicate that, prior to the construction of the Shasta Dam, the IMM mine discharges caused metal levels in the Sacramento River to exceed levels that are safe for aquatic life for more than 330 days each year on average, even after the releases become fully mixed with Sacramento River waters downriver of the confluence of Spring Creek and the Sacramento River. Prior to full mixing, the waters would have been even more toxic to exposed resources.

In 1963, USBR constructed the SCDD to help control the toxic releases from Spring Creek and to prevent sediment from forming a delta in the vicinity of the Spring Creek Powerplant tailrace. The SCDD allows for the storage and controlled release of water from the Spring Creek basin. Optimally, releases from SCR are timed to coincide with releases from Shasta Lake to meet interim water quality criteria in the Sacramento River. However, because the capacity of SCR is not sufficiently large to contain peak discharges from the Spring Creek watershed, large flows can cause the highly polluted SCR waters to spill over the reservoir in an uncontrolled manner. The SCDD has reduced but not eliminated the incidence and severity of major fish kills in the Sacramento River below Keswick Dam and in Keswick Reservoir. As a result of discharges from IMM, soluble metal levels below Keswick Dam can be just below the State Basin Plan Standards (SBPS) for much of the wet season, and metal levels in the Spring Creek arm of Keswick Reservoir (SCAKR) exceed those standards on a regular basis. (See EPA's 1996 *Water Management Feasibility Study Addendum* (FSA), Volume II, Appendix G.) As would be expected from these large metal loads, fish tissue samples from Keswick Reservoir trout have some of the highest levels of cadmium and copper in the state.

The most significant IMM sources of metals are currently being controlled, but the IMM releases are still too large to prevent toxic levels of metals in Keswick Reservoir and, under certain conditions, in the main stem of the Sacramento River below Keswick Dam. During storms in 1995 and 1996, SCR waters, with full treatment of the three major mine discharges (which EPA estimates controlled approximately 80 to 90 percent of the metal load from the Site), exhibited levels of contamination of 400 to 800 parts per billion (ppb) dissolved copper (compared to the existing SBPS of 5.6 ppb copper) and 600 to 1,200 ppb dissolved zinc (compared to the existing SBPS of 16 ppb zinc). Storm inflows into the SCR can exceed 1,000 cfs. Sacramento River flows are frequently near minimum legal flows during the first storm of the season, or not more than 10,000 cfs. Under these conditions, the Sacramento River flows cannot provide sufficient dilution of the IMM AMD-contaminated Spring Creek watershed surface waters at current levels of contamination to prevent the IMM discharges from causing exceedances of water quality standards in the Sacramento River. At the current status of the IMM Superfund cleanup action, with full-scale treatment of the three major IMM sources, IMM discharges will continue to cause exceedances of water quality standards below Keswick Dam even under best-case assumptions regarding SCDD operations.

The two most important factors which currently make it impossible for the SCDD to permit dilution of IMM AMD in a manner that maintains water quality conditions in the Sacramento River within safe bounds for ecosystem protection are: (1) the storm inflows to the SCR are highly contaminated from IMM, and (2) storms that cause these contaminated waters to fill the reservoir within just a few days will likely occur every 5 to 10 years. Significant further remediation of the IMM area source AMD discharges is required to ensure that the existing SCDD will be able to provide sufficient capacity to avoid exceedances of water quality standards below the SCDD.

II.4 History of Federal and State Site Investigations

Remedial investigation (RI) activities at Iron Mountain began in September 1983, when Iron Mountain was placed on the National Priorities List of the nation's most contaminated sites.

In conjunction with EPA's Record of Decision (ROD1) for the first operable unit at Iron Mountain, EPA issued a remedial investigation/feasibility study (RI/FS) report in 1985 and an FS Addendum in 1986. The 1985 RI report characterized the entire IMM Site with respect to the nature and extent of contamination. The EPA's Public Health Risk Assessment was updated in 1991. Site characterization studies continued for the Boulder Creek watershed, and EPA prepared a second RI/FS report for that area in 1992. An Endangerment Assessment (EA) was prepared in 1992 to characterize and evaluate the current and potential threats to the environment that may be posed by IMM contaminants migrating to the groundwater, surface water, and air. Site characterization studies continued for the Slickrock Creek watershed, and EPA prepared an RI/FS report for that area in 1993. The EPA issued its Water Management FS in 1994, the Boulder Creek Remedial Alternatives Study in 1995, and the Water Management FS Addendum in 1996.

The EPA signed the first Record of Decision for the IMM Site in October 1986. ROD1 selected an interim remedy at the Site, identifying a number of specific projects. These projects included the construction of a partial cap over the Richmond mineralized zone, including a cap of Brick Flat Pit; construction of a diversion in Slickrock Creek to avoid an AMD-generating slide; construction of a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling SCR; construction of a diversion of the South Fork of Spring Creek for a similar purpose; a study of the feasibility of filling mine passages with low-density cellular concrete; and an enlargement of SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies. EPA tentatively selected a 9,000-acre-foot reservoir size in ROD1 although the underlying studies indicated that a 15,000-acre-foot reservoir would be required for a protective remedy. In its tentative selection of a smaller reservoir size, EPA relied on a fund-balancing waiver, which permits EPA to waive compliance with protective standards for cleanups that are being paid for by the Superfund.

The Boulder Creek Operable Unit (OU) ROD, signed in September 1992, addressed remedial actions for (1) AMD from the Richmond and Lawson portals, the two largest sources of acidity and metals contamination at Iron Mountain; and (2) the numerous waste rock piles, tailing piles, seeps, and contaminated sediments that also affect contaminant levels in Boulder Creek. The Old/No. 8 Mine Seep OU ROD, signed in September 1993, addressed the third largest source of contaminant discharges at IMM.

On the basis of the results of its ongoing monitoring program, EPA concluded that the area source discharges of heavy metals, especially copper, zinc, and cadmium, were closely associated with the intense storm-related high runoff events that characterize the hydrology of the Spring Creek watershed at IMM.

Through a formal action in 1991 known as an explanation of significant difference (ESD), EPA revoked the fund balancing waiver upon which EPA relied for ROD1. This formal action removed the legal basis for EPA's tentative selection of a 9,000-acre-foot reservoir in ROD2 in lieu of a larger, more protective dam. Consistent with the SCDD enlargement component of ROD1 and the ESD, EPA conducted engineering and other studies regarding enlarging the SCDD. These studies indicated that a reservoir of at least 15,000 acre-feet would be required. Due to the projected increased costs of the SCDD enlargement and the availability of other new information, EPA decided to expand its studies, re-evaluate other remedial technologies, and publish for public review and comment a new feasibility study and proposed plan.

In June 1994, EPA published a Water Management FS, which examined potential remedial alternatives that could control, treat, or manage the safe release of continued uncontrolled contaminant discharges from the numerous and widely dispersed area sources in the Boulder Creek and Slickrock Creek watersheds at IMM. In the 1994 Water Management FS, EPA developed five alternatives for detailed evaluation. These alternatives included a range of approaches that relied on source control, collection and treatment, and water management technologies. Although some area sources could be readily identified and remediated (such as waste piles), a large proportion of the area source discharge was, in general, difficult to identify and characterize. Proven cost-effective, source-specific remedial approaches for these sources are often either unavailable or difficult to identify. Generally, the expected effectiveness of identified source control approaches for these sources is highly uncertain. As a result, the approaches used in the remedial alternatives developed and evaluated in the Water Management FS relied more heavily on collection and treatment and water management rather than on source control..

In June 1994, EPA issued a Proposed Plan with a set of remedial actions for the IMM area source AMD discharges. The Proposed Plan largely relied on a water management approach, with some additional treatment of IMM AMD discharges, consisting of the following three components:

1. Collect and treat the contaminated base flows of Slickrock Creek;

2. Enlarge the SCR to 15,000 acre-feet to enhance water management capabilities for the Site; and

3. Study the technical and administrative feasibility of purchasing dilution water to mitigate the rare contaminant spills that would be expected to occur under this approach.

The EPA invited public comment on EPA's analyses, the alternatives that EPA developed and evaluated, and EPA's preferred alternative.

During the public comment period for the 1994 Proposed Plan, a potentially responsible party (PRP), Rhone-Poulenc, Inc. (Rhone-Poulenc) (through its representative, Stauffer Management Company [SMC]) submitted a Focused Feasibility Study (FFS). Like the EPA feasibility study, the FFS identified a range of general collect and treat alternatives for the area source releases from the Slickrock Creek watershed. Rhone-Poulenc urged EPA to delay selecting a remedy so that an additional season of data could be collected.

The EPA reviewed and analyzed the alternatives developed in Rhone-Poulenc's 1994 FFS, as well as other comments submitted during the comment period. The EPA determined that delay in remedy selection was justified because the information submitted by Rhone-Poulenc suggested that it was technically feasible (and also more cost-effective) to control the IMM pollution on the mountain rather than simply diluting pollution by enlarging the SCDD.

This delay permitted Rhone-Poulenc and EPA an opportunity to collect additional data. Over the 1994-95 wet season, Rhone-Poulenc implemented a substantial data-gathering program to characterize the IMM area source AMD discharges. This data acquisition program included activities intended to identify and characterize Boulder Creek area sources to support an effort to develop and evaluate source-specific remedial approaches. Rhone-Poulenc did not investigate source-specific controls for the Slickrock Creek area sources, but rather directed its efforts toward general collect and treat approaches such as the Slickrock Creek dam and treat approach. Rhone-Poulenc performed engineering studies intended to further characterize and define key hydrologic and engineering factors for the development and evaluation of the Slickrock Creek "dam and treat" approach. Rhone-Poulenc also developed remedial design concepts for proposed Slickrock Creek and Boulder Creek remedies. The data collected by Rhone-Poulenc confirmed EPA's earlier determination that additional response actions were needed to control the releases from IMM (as well as EPA's estimates of the effectiveness of the remedial steps implemented to date).

The EPA also performed independent engineering, laboratory, and field studies and reviewed and prepared analyses of the data generated by the Rhone-Poulenc sampling effort. The EPA participated in technical meetings with Rhone-Poulenc to develop remedial design concepts for a Slickrock Creek "dam and treat" remedy.

To ensure that technically implementable remedies were available for the Boulder Creek watershed, EPA conducted a Boulder Creek Remedial Alternatives Study in 1995, which evaluated the technical feasibility of remediating Boulder Creek area sources to various target cleanup levels. Rhone-Poulenc also studied the feasibility of remediating Boulder Creek area sources. Both EPA's and Rhone-Poulenc's studies concluded that the Boulder Creek area sources could be remediated to within the range of potential target cleanup levels presented by EPA as part of the 1995 Boulder Creek Remedial Alternatives Study.

In August 1995, EPA and Rhone-Poulenc presented their respective analyses and conclusions with regard to the ongoing Boulder Creek studies to a panel of senior technical specialists for review and technical comment. The EPA requested that the panel evaluate the feasibility of remediating the Boulder Creek area sources to achieve a range of potential cleanup criteria. The Boulder Creek Peer Review panel members concurred that the range of potential cleanup targets for Boulder Creek could be met through a program of Boulder Creek remedial actions. The independent peer review panel members' comments presented a range of opinions on the preferred technical approach for remediating the Boulder Creek metal discharge sources. Consistent with the panel comments, EPA concluded that adequate control of the Boulder Creek area sources was feasible, but deferred action on developing and evaluating proposed remedial approaches for these sources to allow time for additional study.

The EPA incorporated these and other investigations into a Water Management Feasibility Study Addendum (FSA) in May 1996. The FSA evaluated an additional remedial alternative as a supplement to the June 1994 Water Management Feasibility Study. EPA's May 1996 Public Comment Water Management FSA updated the public record to include an evaluation of an alternative that addressed only the remediation of Slickrock Creek, Alternative SR1. The 1994 FS evaluated remedial options that would respond to all AMD releases from the Site. In particular, the alternatives would have addressed both the Slickrock and Boulder

Creek sources through source control, treatment, or water management remedial approaches. In May 1996, EPA formally announced that it proposed to select Alternative SR1 as its "Preferred Alternative" for the contaminated Slickrock Creek flows. The EPA proposed to perform additional studies regarding the Boulder Creek area source AMD discharges to support further development and evaluation of alternatives for decision making.

II.5 History of CERCLA Enforcement Activities and Remedial Actions

The EPA's Superfund program became involved with the Iron Mountain pollution problem shortly after the enactment of the Superfund law in December 1980. On April 5, 1982, EPA issued general notices of liability to SCC and IMMI for the past and continuing releases of hazardous substances from Iron Mountain and the resulting damage to and destruction of natural resources.

The IMM Site was listed on the National Priorities List in 1983. From 1983 through 1985, EPA conducted an RI/FS of the Site and published its report in 1985. After public comment and publication of a Feasibility Study Addendum, EPA signed ROD1 in October 1986. That ROD selected an interim remedy at the Site, which included a number of specific projects. These projects included the construction of a partial cap over the Richmond mineralized zone, including a cap of Brick Flat Pit; construction of a diversion in Slickrock Creek to avoid an AMD-generating slide; construction of a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling SCR; construction of a diversion of the South Fork of Spring Creek for a similar purpose; a study of the feasibility of filling mine passages with low-density cellular concrete; and an enlargement of SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies.

During 1987 and 1988, EPA sought a court order to ensure access to the Site for the purpose of constructing the first of these actions. The court granted EPA access and ordered the property owner not to interfere with the remedial actions. On July 19, 1988, EPA initiated construction of the partial cap over the Richmond mineralized zone. As part of that construction, EPA remediated tailings materials from the Minnesota Flat area and other selected areas, by placing the materials into Brick Flat Pit below an impermeable membrane or "cap." The EPA completed construction of the partial cap in July 1989. The EPA, through the USBR, began construction of the Slickrock Creek diversion in July 1989 and completed construction in January 1990. Under EPA Administrative Order 90-08, Rhone-Poulenc, the successor to Stauffer Chemical Company (through its indemnitor, ICI Americas, Inc. [ICIA]), began construction of the Upper Spring Creek (USC) diversion in July 1990. The USC diversion became operational in January 1991.

In addition to the activities implemented pursuant to ROD1, EPA recognized the need for additional actions. During the 1988-89 wet season, EPA operated an emergency treatment plant at the Site to reduce the toxicity of the AMD releases.

In August 1989, EPA issued Administrative Order 89-18, which required the PRPs to operate an emergency treatment plant at the Site to reduce the toxicity of the AMD discharges for the upcoming 1989-90 winter wet season and to provide for metals removal for future years until remedial actions could be selected and implemented. This plant was to be comparable in scope and operation to the plant operated by EPA the previous winter. Pursuant to that order, ICIA, on behalf of Rhone-Poulenc, constructed the treatment plant and operated this treatment plant during the 1989-90, 1990-91, and 1991-92 wet seasons. Because of the continuing drought in California and the critical fishery conditions, EPA issued Administrative Order 92-26 on September 2, 1992, for the 1992-93 wet season, requiring that additional emergency measures be implemented, including increasing the capacity of the treatment plant. The EPA also issued Administrative Order 91-07, requiring the PRPs to operate and maintain EPA-constructed remedial actions and the remedial projects undertaken by the PRPs under other orders.

As part of its ongoing efforts to control the AMD from IMM, EPA conducted an operable unit feasibility study (OUFS) to develop and evaluate remedial alternatives for the AMD discharges in the Boulder Creek watershed. The EPA's 1992 RI report summarizes the data which show the concentration, volume, and historic patterns of releases of AMD from the Boulder Creek watershed at IMM. On September 30, 1992, EPA signed ROD2, a Record of Decision that selected treatment of the AMD discharges from the Richmond and Lawson portals, the two largest AMD discharges at IMM, on an interim basis in a lime neutralization HDS treatment plant. That Record of Decision also selected the consolidation and capping of seven waste piles onsite. Under ROD2, treatment plant sludges are to be disposed of onsite in the inactive open pit mine, Brick Flat Pit, which was modified to comply with applicable disposal standards.

On November 3, 1992, EPA issued Administrative Order 93-01, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Richmond and Lawson portals (including facilities for disposal of treatment sludges). Administrative Order 93-01 also required the PRPs to excavate, consolidate, and cap seven waste piles. Pursuant to that order, ICIA, on behalf of Rhone-Poulenc, agreed to design and construct the treatment plant and to excavate, consolidate, and cap the seven waste piles. However, ICIA opposed EPA's selection of the HDS process technology and performed studies to support its position that the HDS components to the treatment plant should not be constructed. Instead of requiring Rhone-Poulenc to build the HDS component of the treatment plant selected in ROD2, EPA built that component, reserving its rights to recover the costs of doing so.

The EPA continued to conduct studies to control the AMD discharges from IMM and performed an OUFS to develop and evaluate remedial alternatives for the AMD discharges in the Slickrock Creek watershed. In February 1993, EPA published an RI/FS report summarizing data regarding AMD discharges in the Slickrock Creek watershed. The February 1993 RI/FS developed and evaluated remedial alternatives for the Old/No. 8 Mine Seep AMD discharges. On September 24, 1993, EPA signed ROD3, a Record of Decision that selected treatment of the AMD discharges from the Old/No. 8 Mine Seep on an interim basis at the IMM lime neutralization HDS treatment plant, as appropriately modified.

On April 19, 1994, EPA issued Administrative Order 94-12, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Old/No. 8 Mine Seep. Administrative Order 94-12 also required the PRPs to operate the IMM treatment plant. SMC, on behalf of Rhone-Poulenc, agreed to design and construct the collection and conveyance facilities and the necessary modifications to the IMM treatment plant to assure treatment of the Old/No. 8 Mine Seep AMD discharges. Rhone-Poulenc also agreed to operate the aerated simple mix components of the IMM treatment plant.

The aerated simple mix treatment plant became fully operational in October 1994. For the past 3 years, the IMM treatment plant has treated essentially all of the AMD discharges from the Richmond and Lawson portals and the Old/No. 8 Mine Seep. EPA constructed the HDS components of the treatment plant, which became operational in January 1997. The EPA has amended Administrative Order 94-12 to clarify requirements pertaining to HDS plant operations.

The EPA and the State of California have brought a civil suit under CERCLA §107 against the PRPs to obtain reimbursement for government funds spent in responding to the IMM AMD discharges. The cost recovery case is ongoing.

The EPA has identified the following persons as PRPs: the former owner and operator, Rhone-Poulenc, Inc. (the successor to Mountain Copper, Ltd. and its subsidiaries, and Stauffer Chemical Company), and the current owner and operator, Iron Mountain Mines, Inc., and its president and primary owner, T. W. Arman.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The EPA has regularly provided information to the public regarding the Superfund cleanup activities at Iron Mountain. The community has maintained interest in the progress of cleanup at the Site. Prior to the winter wet seasons of 1991 and 1992, community involvement was moderate. Community interest and involvement increased in 1992 as a result of the special release of 92,000 acre-feet of valuable water resources from Shasta Lake to dilute pollution from IMM (during serious drought conditions). Since that time, community and other State and Federal agency interest in the progress of the EPA Superfund cleanup of the IMM AMD discharges has remained significant. Throughout the cleanup activities, EPA has regularly provided information to the local television news and the press regarding the ongoing study and cleanup actions, and this has resulted in significant media coverage. The EPA has provided regular updates on the progress of cleanup actions through the release and distribution of factsheets and through presentations to local community groups.

III.1 Public Participation for Previous RODs

The EPA issued its first Record of Decision for the IMM Site in October 1986. The EPA has issued factsheets regarding that decision and commencement of remedial design (July 1987), commencement of remedial action (July 1988), implementation of emergency response treatment actions (February 1989), and the performance of a demonstration program under EPA's Superfund Innovative Technology Evaluation (SITE) program (August 1991). The EPA also updated its Community Relations Plan, which was finalized in May 1990.

In May 1992, EPA issued a Proposed Plan for the Boulder Creek OU at IMM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The May 1992 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Richmond and Lawson portals and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in June 1992 to present its Proposed Plan, to answer questions, and to receive public comments. In September 1992, EPA issued its second Record of Decision for the Site. The second Record of Decision selected the interim treatment remedy described above.

In February 1993, EPA issued a Proposed Plan for the Old/No. 8 Mine Seep OU to address the AMD discharges from this source at IMM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The February 1993 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Old/No. 8 Mine Seep and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in February 1993 to present its Proposed Plan, to answer questions, and to receive public comments. The EPA issued its third Record of Decision for the Site in September 1993, selecting the interim treatment remedy for these AMD discharges.

In October 1993, EPA issued a Technical Assistance Grant (TAG) to the Shasta Natural Science Association. The grant has provided funding to support the development and dissemination of information to the community regarding EPA's IMM cleanup activities. The TAG was annually extended through March 1997 and has now expired.

III.2 Public Participation for the 1994 Proposed Plan

In June 1994, EPA issued a Proposed Plan to enlarge the SCDD and conduct baseflow treatment of Slickrock Creek area sources (the term baseflow refers to the flow in the creek before, after, and between peak discharge flows related to storm runoff; baseflow treatment was one component of the preferred alternatives from the 1994 Proposed Plan) as the "preferred alternative." During the 60-day public comment period, EPA held a public meeting in Redding, California (July 7, 1994). The proposed action attracted significant community interest and the public meeting was well attended (approximately 50 to 70 private citizens). At the meeting, EPA received oral comments, and several members of the public submitted written comments. The EPA received detailed technical comments from representatives of Rhone-Poulenc. The EPA also received comments from interested State and Federal agencies. In general, the comments from private citizens were supportive of EPA's Proposed Plan. The comments indicated general agreement with EPA's intention to ensure protection of the Sacramento River fishery and water supply. They also indicated agreement with EPA's portrayal of the proposed remedy selection criteria which recognize that cost and technical impracticability factors might limit the extent to which the IMM metals discharge could be controlled and the restoration of the Spring Creek watershed could be implemented.

Other comments included:

- Action should be taken to protect the Sacramento River as soon as possible.
- Action should be deferred until the effectiveness of the IMM treatment plant and the need for additional action could be evaluated further.
- A preference exists for a remedy that would eliminate the metals discharges through controls.

- Continued investigation of such approaches was recommended in conjunction with the water management remedy.

The comments from State and Federal agencies generally supported EPA's preferred alternative. Several agencies indicated a preference for additional source control or treatment remedies, but indicated their willingness to rely on a water management remedy if it could clearly be demonstrated that the other approaches were technically impracticable. Several agencies suggested that additional data should be collected over another wet season. The State requested that EPA re-evaluate the "two-dam" alternative, and indicated an interest in a full evaluation of Rhone-Poulenc's clean water diversion / "dam and treat" approach for Slickrock Creek.

Rhone-Poulenc commented that no further action was necessary at the Site to provide a protective remedy, and that EPA should take no action at this time. Nonetheless, Rhone-Poulenc proposed to implement treatment of contaminated Slickrock Creek base flows. Rhone-Poulenc also submitted comments criticizing specific aspects of the modeling work conducted by EPA in the Water Management FS, EPA's characterization of the IMM area sources and their potential for remediation, EPA's analysis of ancillary environmental impacts associated with an enlargement of SCDD, and EPA's 1994 Fisheries Benefit Analysis. Rhone-Poulenc indicated that it believed there were more cost-effective approaches to reducing the toxic discharges from Slickrock and Boulder Creeks than the ones EPA had identified in its Water Management FS.

In conjunction with its other comments, Rhone-Poulenc submitted an FFS that evaluated several new remedial alternatives. The FFS developed a No Action Alternative, four new alternatives, and presented Rhone-Poulenc's evaluation of EPA's preferred alternative. Although Rhone-Poulenc indicated a belief that no further action was warranted, Rhone-Poulenc proposed to implement treatment of the contaminated Slickrock Creek base flows with additional treatment of identified Boulder Creek sources. Rhone-Poulenc suggested that this alternative should be implemented and evaluated prior to any subsequent actions at the Site. Rhone-Poulenc also developed two alternatives that relied on clean water diversions, and a "dam and treat" approach to control the contaminated discharges from Slickrock Creek, but concluded that these alternatives were not needed at this time and could be implemented later if subsequent monitoring demonstrated their need.

The EPA considered and analyzed in detail comments received from Rhone-Poulenc and other members of the public. The EPA conducted further investigatory and sampling work to develop additional data on the issues identified by Rhone-Poulenc. The EPA's review concluded that there are additional alternatives that may provide for a cost-effective source control and treatment approach for remediation of the Slickrock Creek area sources. On the basis of this review and the technical merit of some of the alternatives developed by Rhone-Poulenc, EPA deferred action on remedy selection from 1994 to 1997 to perform additional studies of these potential source control and treatment alternatives. Detailed responses to the public comments on the 1994 Proposed Plan are included in the Response to Comments document. In addition, the 1996 Water Management FSA includes a discussion of the major comments raised in connection with the 1994 Proposed Plan.

III.3 Public Participation for the 1996 Proposed Plan

In May 1996, EPA issued a revised Proposed Plan to implement a "dam and treat" remedy largely derived from the most effective alternative identified by Rhone-Poulenc in the FFS. The remedy involved diverting upper Slickrock Creek flows (and flows from the unmined side of Slickrock Creek Valley) around the most heavily mining-impacted reach of Slickrock Creek and collecting and treating the reach of Slickrock Creek that is most heavily impacted by past mining activities. The EPA proposed to perform further study of the Boulder Creek area source AMD discharges to support the additional development and evaluation of remedial alternatives for these sources. The public comment period was held for 60 days (EPA extended the public comment period in response to a request from Rhone-Poulenc). On May 23, 1996, EPA held a public meeting in Redding, California, to present EPA's Proposed Plan, to answer questions, and to receive public comments. The EPA also participated in a June 12, 1996, community workshop that was organized by the Shasta Natural Science Association (the IMM TAG grantee) to present the Proposed Plan, answer questions, and invite community participation in the decision making process.

The EPA received detailed written technical comments on the May 1996 Proposed Plan from Rhone-Poulenc and its representatives (EPA considers the comments submitted on behalf of Rhone-Poulenc collectively as the comments of Rhone-Poulenc). The EPA also received written comments from interested State and Federal agencies, but no comments from the general public. Rhone-Poulenc continued to submit comments and information after the close of the public comment period, and EPA continued to accept and consider the information submitted by Rhone-Poulenc.

The EPA carefully reviewed, analyzed, and considered the comments that were received. The EPA has provided detailed responses to the comments on the 1996 Proposed Plan (as well as EPA's 1994 Proposed Plan and other technical studies that were performed during the period from 1994 to 1996, including the 1995 Boulder Creek Remedial Alternatives Study) in the Response to Comments document produced in conjunction with this Record of Decision. The Administrative Record includes a transcript of the public meetings held in connection with the 1994 and 1996 Proposed Plans. The balance of this section contains a brief review of principal comments received in connection with the 1996 Proposed Plan.

III.3.1 Summary of State and Federal Agency Comments on 1996 Proposed Plan

In general, the comments from State and Federal agencies were supportive of EPA's 1996 Proposed Plan for the Slickrock Creek area source AMD discharges. All of the agencies agreed that the proposed Slickrock Creek "dam and treat" alternative was preferable to water management approaches, such as EPA's previous 1994 proposal to enlarge the SCDD. Most agencies agreed with EPA's proposal to perform additional study regarding the Boulder Creek area source AMD discharges. However, Mr. Joel Medlin, on behalf of the U.S. Fish and Wildlife Service (USFWS), commented that he believed that sufficient information is currently available to support the selection of a "dam and treat" remedy for the Boulder Creek area source AMD discharges, and he urged EPA to select such a remedy for these sources now. Mr. Roger Patterson, on behalf of the USBR, also stated a strong preference for the implementation of a "dam and treat" remedy for the Boulder Creek area source AMD discharges, but commented that further study may be warranted.

III.3.2 Summary of Rhone-Poulenc Comments on 1996 Proposed Plan

Rhone-Poulenc agrees with EPA that constructing a dam on Slickrock Creek is more appropriate than enlarging the SCDD. Rhone-Poulenc also agrees that the remedy is technically feasible and that the remedy would effectively control the Slickrock Creek area sources. However, Rhone-Poulenc does not concur with EPA that further remedial action is required, and Rhone-Poulenc urged EPA to conduct further studies before proceeding to take any additional actions at the Site.

Need for Further Action

Rhone-Poulenc commented that no further action is appropriate at this time. Rhone-Poulenc bases its position in large part upon its assumption that a response action is not needed to protect the Sacramento River fishery below Keswick Dam. In particular, Rhone-Poulenc commented that despite the intensity of the storm and resulting spill in January 1995 (and the exceedances of the SBPS that occurred during that spill), no toxicity occurred during the January 1995 spill. This position appears to be based largely on the lack of "observed" toxicity in the Sacramento River and a fish toxicity test conducted by a Rhone-Poulenc consultant with water collected during the January 1995 spill.

The EPA agrees that protecting the fishery and other aquatic resources below Keswick Dam is an important goal of the IMM response action, but EPA does not agree that the current level of response is sufficient to protect the fishery or the other resources below Keswick Dam. The metal concentrations that occurred during the January 1995 storm clearly exceeded levels that are acutely toxic to fish and other exposed resources. The lack of "observed" toxicity is not surprising in light of the general size of the Sacramento River downstream of Keswick Reservoir, the difficulty of visually observing dying or dead fish during periods when the water is turbid, and the life stages of fish most likely to have been acutely affected by the toxic conditions, namely eggs, juveniles, and fry, which are also the most difficult to observe. Similarly, the Rhone-Poulenc toxicity tests do not provide a reliable indicator of whether toxicity occurred below Keswick Dam. Although the toxicity test used water collected during the January 1995 spill, the test water was not representative of conditions observed in the river. For example, the water samples closely approximated the SBPS while much higher concentrations existed throughout much of the spill. Although EPA requested the information, the Rhone-Poulenc consultant did not provide quality assurance test results such as positive control (reference toxicant tests) to validate the health and responsiveness of the trout tested during the studies. These tests are standard protocol for the type of experiments conducted by Rhone-Poulenc. Because of the lack of detailed supporting information on testing procedures, it was not possible to perform a full independent review of the testing or for EPA to rely on the test results. The other available evidence strongly indicates that toxicity occurred during the spill. Rhone-Poulenc's comment also does not take into account the continued release of mass loads of heavy metals to the Sacramento River system, which exposes species to long-term sub-lethal levels of metals.

In addition, EPA disagrees with Rhone-Poulenc's assumption that the fishery below Keswick Dam is the only resource at risk from releases from IMM. Significant environmental degradation continues to exist above Keswick Dam as a result of the continuing releases of significant loads of heavy metals and acidity from IMM. The most obvious degradation exists upstream of the SCDD, where practically all beneficial uses are impaired, and the creeks are essentially devoid of aquatic life. IMM releases also severely impair conditions in the Spring Creek arm of the Keswick Reservoir. In sum, EPA believes that the available data clearly establish that current releases of hazardous substances from the Site warrant additional response action. More details regarding the risks posed by releases from IMM and the manner in which this response action will address those risks are discussed extensively in other parts of this document and in other parts of the Administrative Record.

Request for Further Delay

Rhone-Poulenc urges EPA to continue to defer selecting a response action based upon the lack of need for immediate action, the need to collect additional data, the possibility that the Sacramento River flows could change due to new legislation, and the possibility that the SBPS will be made less stringent. The EPA does not believe that a further period of evaluation is warranted. Releases from the Site continue to pose a significant threat to the environment. The available evidence clearly demonstrates the technical feasibility, effectiveness, and cost-effectiveness of the proposed Slickrock Creek "dam and treat" remedy. Additional data acquisition is not expected to substantially alter EPA's understanding of the significance of the Slickrock Creek area source AMD discharges or lead to the identification of cost-effective alternate control strategies. A further delay is also unlikely to lead to changes in Sacramento River flows that would cause the response action to be unnecessary. Information available since 1994 in fact indicates that less water could be available in the future due to other important water needs. Finally, a further delay is not likely to lead to a change in the SBPS that would affect the scope of the response action. As explained below, the available science, which is substantial, supports the reasonableness of the existing SBPS, and the EPA is not aware of any planned changes to the SBPS.

Comments on the EPA Water Quality Model

Rhone-Poulenc also submitted extensive comments on the EPA water quality model. The EPA has relied upon the model as one tool to predict the effectiveness of various remedial alternatives with respect to limiting the frequency of SCDD spills and exceedances of the SBPS below Keswick Reservoir. Rhone-Poulenc states that the model relies upon inappropriate assumptions and that the model lacks predictive ability. The EPA has reviewed the Rhone-Poulenc comments regarding the model. The EPA review revealed that Rhone-Poulenc input improper data to the EPA model which, in turn, caused the model to not function properly. When the model is run correctly, the model predicts, with reasonable accuracy, the types of conditions that would cause SCDD spills and exceedances of the SBPS and the types of conditions that would exist in the main stem of the Sacramento River below Keswick Dam during those spills.

In response to Rhone-Poulenc comments regarding specific model assumptions (and other information obtained since May 1996), EPA conducted additional modeling analyses. Among other things, EPA conducted new model runs using water quality and flow data obtained since the 1996 modeling effort, new flow projections from the USBR, recently proposed water quality criteria (the Proposed California Toxics Rule [PCTR]), and additional information regarding the operational efficiency of the SCDD. This additional analysis, which is set forth in the Response to Comments document, confirms the reliability and reasonableness of the 1996 IMM water quality model (WQM). The model consistently indicates that in the absence of further response actions, exceedances of the SBPS (and the PCTR) will continue to occur on a regular and frequent basis below Keswick Dam.

The EPA also conducted additional analysis of several parameters used in the model. For example, Rhone-Poulenc commented that the EPA model should have relied upon a Spring Creek Reservoir capacity of 5,400 acre-feet rather than 5,016 acre-feet. A review of the Rhone-Poulenc analysis, however, reveals that Rhone-Poulenc did not consider operational constraints that limit the usable capacity of the reservoir to approximately 5,000 acre-feet. Rhone-Poulenc also submitted extensive comments on the precipitation values used in the 1996 model (the precipitation value reflects the extent to which dissolved metals precipitate from solution to form heavy metal particulates as the pH increases due to mixing AMD with less polluted water in Keswick Reservoir). The additional EPA review confirmed the appropriateness of the precipitation values used in the EPA model.

Reliance on SBPS

Rhone-Poulenc commented that the SBPS do not provide a reliable indicator of the need for further remediation because the standards are, according to Rhone-Poulenc, overly conservative and not based on sound science. The EPA does not agree with Rhone-Poulenc that the standards are overly conservative or scientifically unsound. The available information, which is quite substantial, strongly supports the reasonableness of the existing SBPS. Site-specific toxicity tests conducted by the State of California in 1995 and Hagler-Bailly in 1996 indicate that the existing SBPS are appropriate and not overly protective. Those tests are consistent with previous site-specific toxicity tests. To further evaluate the comments submitted by Rhone-Poulenc on the SBPS, EPA sought comment from several other agencies with expertise on this issue, including the CVRWQCB, the National Marine Fisheries Service (NMFS), the NOAA, the USFWS, and the California Department of Fish and Game (CDFG). The comments of these other agencies support EPA's conclusion that the existing standards are a reliable indicator of the need for further response action and that the standards are not overly conservative.

In addition, EPA's Water Management Division recently proposed new statewide water quality criteria for the State of California, the PCTR. The EPA developed these criteria using EPA's most current guidance for developing water quality criteria. Because the new criteria are not yet finalized, the proposed criteria qualify as "To Be Considered Standards" rather than potential ARARs. The PCTR are more stringent than the SBPS with respect to the need for further response action at IMM. These criteria therefore indicate that the SBPS are a reasonable indicator of risk to aquatic resources in the Sacramento River.

Rhone-Poulenc comments that EPA should waive the SBPS on the basis of technical impracticability for areas of Slickrock Creek. The EPA is adopting an interim waiver for compliance with those standards for this interim remedy. The EPA is still evaluating whether a permanent partial waiver of the SBPS is appropriate.

Rhone-Poulenc submitted several legal arguments to support its position that EPA should not adopt the SBPS as ARARs (among others, (1) the standards were adopted specifically to serve as cleanup objectives at the Iron Mountain Site, (2) the SBPS are not of general applicability and have not been consistently applied, and (3) the standards do not properly apply to the tributaries of the Sacramento River such as Spring Creek and Slickrock Creek). As explained more fully in the Response to Comments document, EPA does not agree with Rhone-Poulenc's comments on this issue.

Need for Slickrock Creek Retention Pond

Rhone-Poulenc also objects to the proposed Slickrock Creek remedy on the basis that the retention pond is not necessary to meet the Basin Plan Objectives in the Sacramento River and that, if EPA selected additional response action at the Site, EPA should select baseflow treatment of Slickrock Creek AMD flows. However, baseflow treatment would not meet the requirements of CERCLA. Baseflow treatment is significantly less effective than Alternative SR1 with respect to metal removal. For example, implementing Alternative SR1 in lieu of baseflow treatment would eliminate an additional discharge load of copper of 8,000 to 27,000 pounds per year. This additional copper reduction associated with Alternative SR1 compared to baseflow treatment is roughly equal to 33 percent to 100 percent of the load discharged from all of the regulated dischargers of copper to the Sacramento River system, including the San Francisco Bay and Delta.

Baseflow treatment is also less effective with respect to reducing the frequency and duration of exceedances of the protective SBPS in Keswick Reservoir. While exceedances in Keswick Reservoir are expected to continue under either alternative, Alternative SR1 would be expected to reduce the frequency, duration and degree of the exceedances.

Baseflow treatment is also less effective than Alternative SR1 with respect to protecting the Sacramento River below Keswick Dam. Even after baseflow treatment is implemented, SCDD spills are expected to occur every 3 to 4 years, which is approximately twice the spill frequency expected after implementation of Alternative SR1 (which is expected to reduce spill frequency to once every 8 to 10 years). SCDD spills typically cause SBPS and PCTR exceedances below Keswick Dam lasting from one day to several weeks. If the SCDD were operated to meet the PCTR chronic criteria for copper, the frequency of exceedance would be greater under each approach, but the duration of the exceedances would be significantly longer for the baseflow treatment approach than under Alternative SR1.

Baseflow treatment would also be less effective than Alternative SR1 with respect to restoring the beneficial uses of waterbodies and habitat values in the Spring Creek watershed.

A remedial action that does not address these risks when other technically practicable and implementable alternatives are available to establish more protective conditions, does not meet the requirements of CERCLA for remedy selection (40 C.F.R. § 300.430(f)(1)(i)(A) and (ii)(A) and (B)).

Rhone-Poulenc recently proposed to study the feasibility and effectiveness of installing french drains in the Slickrock Creek Basin and a surface water collector in the Big Seep area in Slickrock Creek to control area sources. EPA had previously considered the appropriateness of alternative groundwater and surface water collection approaches in its technology screening process for the 1994 and 1996 feasibility studies. Groundwater interception approaches are considered to be inappropriate technologies for addressing Slickrock Creek area sources generally. The groundwater flows are only a minor component of the Slickrock Creek area sources, so a groundwater collection system would not provide a sufficient degree of protection or comply with other CERCLA requirements. EPA's review of data developed since 1996 confirmed the earlier conclusion regarding this issue. Rhone-Poulenc also proposed to study the collection and treatment of a limited amount of surface water, but the approach proposed by Rhone-Poulenc is not technically feasible. The proposed location of the surface-water collection system, the Big Seep area, is highly unstable and in the midst of a massive waste disposal area. Massive amounts of sediments are expected to come down from the debris slide and impact efforts to collect surface runoff without extensive sediment controls. The peak nature of the runoff would be expected to adversely impact efforts to assure treatment of the discharges without adequate flow equalization. The EPA has concluded that the proposed Rhone-Poulenc alternative would not be effective in capturing the majority of the Slickrock Creek area source metal discharges. The EPA also believes that Rhone-Poulenc underestimates the cost of this proposed approach. The surface-water collection system would cost substantially more than Rhone-Poulenc estimates because additional flow equalization facilities and sediment controls are necessary to allow surface-water collection and treatment efforts.

Rhone-Poulenc also commented that EPA did not adequately justify several particular design components of the proposed alternative, including the hematite containment structure, the 5-acre sedimentation pond, a microtunnel between the HDS plant thickener and Spring Creek, and restoration of montane hardwood-conifer habitat. As explained more fully in the Response to Comments document, each of these components is an important part of the selected remedy.

Naturally Occurring Substances

Rhone-Poulenc objects to the remedy on the ground that installation of the Slickrock Creek retention pond will clean up Slickrock Creek to below "natural background levels." In support of its position, Rhone-Poulenc submitted numerous technical reports that purport to estimate metal loads attributable to "natural sources" at Iron Mountain. Rhone Poulenc relies on these reports to conclude that a significant portion of metals loading to Slickrock Creek is attributable to "natural sources."

Rhone-Poulenc's comments on this issue concern the limitation contained in CERCLA Section 104(3)(A). That section provides that "[t]he President shall not provide for a removal or remedial action under [Section 104] in response to a release or threat of release–(A) of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found."

The Slickrock Creek remedy is consistent with EPA's authority under CERCLA. The remedial response is directed at responding to releases altered by mining. As shown in Photo Exhibits 1 and 2, the selected remedy focuses on collecting the releases from the portion of the Slickrock Creek basin that is most heavily disturbed by mining. The area sources of these metals include buried mine portals, mine seeps, waste piles, tailing piles, and buried mineralization exposed by mining through fracturing, lowering of the water table, and removal of surface materials. Water from upstream of the heavily disturbed mining area and from the unmined side of the valley will be diverted around the disturbed mining area. These diverted flows will not be collected or treated at the IMM treatment plant as part of this remedy.

Despite detailed study of Site conditions and review of the extensive data and analysis submitted by Rhone-Poulenc, EPA has been unable to identify any release of hazardous substances from the Slickrock Creek area sources being addressed in this response action that are unaltered by mining. To the extent that such releases may exist, the releases would be commingled with and indistinguishable from the mining-related sources (and therefore "altered" by those releases). Even if such releases could be identified, EPA is aware of no cost-effective, protective, and reliable alternative that would be capable of isolating the mining-related releases from the "release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found." The EPA is also not aware of any alternative that would restore the hydrology and geology to its pre-mining condition, which essentially isolated the fresh mineralization from conditions that permit the rapid and extreme release of large loads of highly acidic and metal-laden waters.

The EPA has also reviewed and analyzed the reports submitted by Rhone-Poulenc on this issue. Several of the reports attempt to estimate the pre-mining baseline metal loads. The focus on pre-mining metal concentrations, however, does not address the central issue: whether or not a remedial action is taken in response to a release or threat of release "of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found." Even if it were appropriate to evaluate pre-mining metal loads, the studies submitted by Rhone-Poulenc do not provide an accurate estimate of pre-mining metal discharges. For example, the Rhone-Poulenc reports rely heavily upon water samples collected in the highly disturbed mining area. The reports incorrectly assume that these samples are "undisturbed" by mining and represent "natural background conditions." The reports also rely on other analyses that fail to account for changes induced by mining. As a result, the reports greatly overstate the pre-mining metal levels.

A few of the Rhone-Poulenc reports do try to distinguish between current releases associated with mining versus current "natural" releases, but those reports fail to accurately distinguish between these two categories. For example, the reports assume that all weathering of mineralization is natural. Although weathering of mineralization is a natural process that occurred prior to the time when mining commenced, mining has significantly altered the weathering of mineralization by exposing fresh sulfides to oxygen and water through a host of actions. These changes have greatly increased the rate of oxidation, acidification of water, and release of metals. Such releases are therefore altered by mining and not within the limitation contained in CERCLA Section 104(3)(A).

The EPA also evaluated actual field conditions to assess the validity of the natural background estimates presented by Rhone-Poulenc. These methods include application of the Rhone-Poulenc natural background model to an unmined mineralized area at IMM, evaluation of geologic data regarding the time the mineralization has been exposed to atmospheric conditions, and biologic and genetic studies of areas upstream of the mine-impacted area.

The EPA applied the Rhone-Poulenc natural background model to an unmined mineralized area at IMM. The model predicted copper concentrations ranging from 2,420 to 4,120 ppb and zinc concentrations ranging from 850 to 1450 ppb. When the actual values are measured, however, the concentrations range from 3.7 to 9.4 ppb for copper and 17.3 to 33.8 ppb for zinc. This large degree of error indicates that the Rhone-Poulenc model is not a reliable indicator of pre-mining metal loads.

The EPA also evaluated the Rhone-Poulenc pre-mining metal estimates by examining the available geologic evidence to determine if those rates are geologically possible in light of the time needed to create the gossan deposit at IMM. The pre-mining metal release rates suggested by Rhone-Poulenc indicate that the mineralization has been exposed for less than 50,000 years (based on the current volume of gossan and numerous conservative assumptions that would tend to overstate the period of exposure). Recent paleomagnetic investigations reveal that the gossan has been exposed at least since the last reversal in the earth's magnetic field, which occurred more than 780,000 years ago. This evidence also indicates that the pre-mining release rates predicted by Rhone-Poulenc are gross overstatements.

The Rhone-Poulenc hypothesis regarding pre-mining metal concentrations is also inconsistent with biologic and genetic studies conducted by EPA that indicate that, in the pre-mining period, metal concentrations in Spring Creek, Boulder Creek, and Slickrock Creek were at sufficiently low levels such that each of these surface waters supported a healthy aquatic ecosystem.

In sum, each of the independent methods used by EPA to evaluate pre-mining metal loads indicates that pre-mining metal loads were at most a very small fraction of the current loads being released from IMM.

Cost-Benefit Analysis

Rhone-Poulenc commented that EPA should have conducted and considered a cost-benefit analysis that weighs the costs of the proposed remedial action with any benefits that may derive from the remedial action to the fishery below Keswick Reservoir. The manner in which EPA is to consider costs (and benefits) is set forth in the NCP, and those provisions do not require the type of analysis suggested by Rhone-Poulenc. The NCP is carefully structured so that "protection of human health and the environment" will not be compromised by other selection factors, such as cost. See 55 Fed. Reg. 8726 (1990). Although EPA balances nine selection criteria (including cost) in selecting a remedy, all of the criteria are not given equal weight. Instead, they are divided into three classifications: threshold criteria, balancing criteria, and modifying criteria. Only remedies meeting the threshold criteria (overall protection of human health and the environment and compliance with ARARs) are eligible for consideration in the balancing process by which the remedy is selected. Rhone-Poulenc also incorrectly assumes that protecting the fishery below Keswick Dam is the only benefit of the response action.

The EPA considered cost and cost-effectiveness in conducting its scoping analysis, analyzing alternatives, identifying a preferred alternative, and selecting this response action. Through the FS scoping process, EPA identified technologies and remedial alternatives that could potentially meet the threshold requirements. In the Water Management FS and Water Management FSA, EPA evaluated and considered the cost (including all capital costs and the present worth of all operating and maintenance costs) of those alternatives as one of several balancing criteria. As discussed above, alternatives that do not meet the threshold requirements (such as Slickrock Creek baseflow treatment in the absence of enlarging the Spring Creek Debris Dam) are not eligible for consideration in the balancing process.

In selecting the remedy, EPA considered the cost-effectiveness of the selected remedy, as required by the NCP, by evaluating the overall effectiveness of the proposed Slickrock Creek alternative in proportion to its cost. 40 CFR § 300.430(f)(1)(ii)(D). The EPA determined the overall effectiveness by evaluating the alternative's long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. *Id.* The overall effectiveness was then compared to cost to evaluate whether the alternative was cost-effective. As set forth below, this analysis indicates that the selected remedy is cost-effective. The EPA also considered cost in evaluating the statutory preference for treatment as a principal element of the response action.

Consistency with Final Remedy

Rhone-Poulenc commented that EPA had failed to ensure consistency of the proposed action with a final remedy for the Site. As set forth elsewhere in this ROD, the Slickrock Creek remedy makes significant progress toward meeting the remedial action objectives of the IMM CERCLA response action. While the response action is likely to continue for some time and other response actions might be developed in the future (such as resource recovery), the interim action is not inconsistent with those types of final remedies. The manner in which this response action fits within the overall Site response action is set forth more fully in the following section.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT WITHIN SITE STRATEGY

IV.1 Role of the IMM Remedial Action

The overall objective of EPA's IMM Superfund cleanup program is to eliminate IMM AMD discharges that are harmful to human health and the environment. Due to the complexity and magnitude of the pollution problem, EPA divided the IMM response action into separate operable units. This approach enabled EPA to address the most serious problems quickly and to achieve a rapid reduction in hazardous substance releases. Remedial steps already implemented at the Site have reduced the heavy metal load release by approximately 80 to 90 percent. Despite the effectiveness of the remedies already implemented, releases from the Site still cause the receiving waters in the Spring Creek watershed to be essentially devoid of aquatic life, the release of significant heavy metal loads to Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River, and exceedances of protective standards in the Sacramento River and Keswick Reservoir on a regular basis. Additional response actions are needed to address these remaining problems. The most significant remaining areas in need of a response action include (1) the area sources in the Slickrock Creek basin (constituting approximately 60 to 70 percent of the copper and 40 to 50 percent of the zinc and cadmium releases that are currently uncontrolled), (2) the area sources in the Boulder Creek basin (constituting approximately 30 to 40 percent of the copper and 50 to 60 percent of the zinc and cadmium releases that are currently uncontrolled), and (3) the heavy metal sediments associated with past and current releases of IMM AMD (including sediments in Spring Creek and its tributaries, SCR, Keswick Reservoir, the Sacramento River, Flat Creek, and other areas). Studies of these problems are currently underway. These additional studies will also assess the feasibility of further source control and the appropriateness and feasibility of relying on water management options as a component of a final Site remedy, and the need for other response actions. Proceeding in this phased manner enhances the ability of EPA to evaluate the feasibility of restoring portions of the receiving waters in the Spring Creek watershed and other affected water bodies.

IV.2 Scope of the Problem Addressed by the Selected Remedial Action

The specific problem addressed in this remedial action is the release of metals and acidity in the AMD from the area sources in the Slickrock Creek watershed at IMM. The response action is expected to essentially eliminate the discharges from the sources being addressed in this interim action. The collected flows, which will account for approximately 60 to 70 percent of the copper and 40 to 50 percent of the zinc and cadmium releases that are currently uncontrolled, will be treated to remove more than 99 percent of the metals and to neutralize the acidity of the water. The releases addressed by this response action contribute a significant metal load and acidity to the receiving waters. The releases cause or contribute to exceedances of the protective water quality standards, including the SBPS and the proposed California Toxics Rule (PCTR), in Slickrock Creek, Spring Creek, SCR, Keswick Reservoir, and in the Sacramento River below Keswick Dam.

The State of California set the SBPS to assure protective conditions for the Sacramento River fishery and the ecosystem in the upper Sacramento River and its tributaries. The SBPS were reviewed and approved by EPA as a Federal standard under the Clean Water Act. The PCTR are proposed numeric statewide water quality criteria for the State of California. The proposed water quality criteria for aquatic life and human health are designed to establish pollutant levels that would protect aquatic life and human health, respectively. The proposed aquatic life criteria include criteria based on both short-term and 96-hour exposure durations. These two exposure values are intended to represent average pollutant concentrations which will produce water quality generally suited to maintenance of aquatic life. Exceedance of the SBPS (or the PCTR) indicates that aquatic resources are not being adequately protected. The Slickrock Creek area source AMD discharges also result in the formation of toxic sediments in SCAKR and in the main body of Keswick Reservoir and the release of significant volumes of heavy metals in particulate form into the water column of the Sacramento River.

Since this interim remedy is not intended to address all remaining uncontrolled AMD releases, the interim remedy continues to rely on continuing operations of the SCDD to provide for the safe release of the continuing IMM contaminant discharges from the SCR (to the extent technically feasible in light of the current state of the response action at IMM). The interim water management actions are necessary to reduce the likelihood of uncontrolled SCDD spills, reduce the reliance on special releases of CVP waters to dilute IMM AMD-contaminated surface waters, and meet the SBPS for water quality to the extent feasible. Consistent with the analysis in the Water Management FS, EPA anticipates that the operational targets of the SCDD can be revised to reflect the reduced metal loads from IMM once this remedial action has been implemented. Based upon the current operational procedures used by USBR, these changed operational targets would likely be able to attain the SBPS (and potentially the PCTR) below Keswick Dam under most circumstances, although regular exceedances in areas of Keswick Reservoir and in the Spring Creek watershed are likely to continue without further response action at the Site.

This Record of Decision represents an interim remedy for a portion of the Site, so EPA has considered the need of this remedy to be consistent with future remedial action and the need to reduce significant risks as soon as possible. This interim action addresses the most significant source of currently uncontrolled IMM AMD–the Slickrock Creek area sources entering the reach of Slickrock Creek directly below the most heavily disturbed mining area. The selected remedy is consistent with other potential response actions for the remaining IMM discharges. The remedy is consistent with remediation of existing sediments because the remedy significantly reduces the release of new precipitates into the waters of the state. The remedy is consistent with a response action on Boulder Creek because this remedy does not affect a response action for those sources and takes into account a range of possible actions on Boulder Creek. The remedy is also consistent with reliance on resource recovery once that technology is developed, since the collection systems could potentially be utilized to implement such a system.

V. SITE CHARACTERISTICS

V.1 Contamination

Analytical data collected over several decades indicate that IMM is releasing large volumes of hazardous substances to the environment via AMD discharges. The IMM AMD originating in the Slickrock Creek basin is characterized by its extremely low pH (resulting in a pH of approximately 3 in Slickrock Creek) and very high concentrations of heavy metals (causing current copper concentrations in Slickrock Creek to range from 1,200 to 5,800 ppb during the 1995-96 water year, which is several orders of magnitude more concentrated than the SBPS for copper).

The water quality parameters of concern from a public health exposure perspective are pH, cadmium, copper, and zinc. These parameters are selected because of potential dermal contact effects caused by low pH and potential consumption of AMD (with these three metals being of greatest concern from a water consumption perspective).

The contaminants of concern from the perspective of fisheries (salmon, steelhead trout and other aquatic resources) exposure are pH, cadmium, zinc, copper, and aluminum. These parameters are selected because of their toxicity in the receiving waters to aquatic resources such as salmonids. Those species are sensitive to low pH waters and waters containing metal concentrations ranging from 1 μg/L for cadmium to 100 μg/L for aluminum (copper toxicity levels are in the range of 10 μg/L, and zinc toxicity levels are in the range of 50 μg/L). Recently conducted studies reinforce the sensitivity of aquatic resources (including fish and algae) to even lower levels of these metals. For comparison, 1 µg/L equals approximately 0.001 mg/L or 1 part per billion (1 ppb).

The contaminants of concern with respect to terrestrial wildlife include arsenic as well as those listed above for aquatic species.

Since October 1994, essentially all AMD discharges from the three largest point sources at IMM have been treated at the IMM treatment plant. Over this period, the IMM treatment plant operations have reduced the uncontrolled IMM discharges of copper, zinc, and cadmium by approximately 80 to 90 percent.

The remaining IMM AMD discharges derive from the widely dispersed area sources. The IMM area sources include waste piles, sidecast spoils, ground disturbed by mining-related activities, discharges from buried workings or partially accessible workings, contaminated soil and debris, seeps, contaminated groundwater, and contaminated sediments in the Slickrock Creek, Boulder Creek, and Spring Creek watersheds at IMM.

The area sources tend to have very complex characteristics that cause the relative significance of the source to vary depending on a host of factors, including storm duration, storm intensity, and antecedent moisture condition. Significant portions of the sources are buried and difficult to locate without an expensive investigation. Some of these buried mine-impacted sources discharge below large landslide areas. Other sources are located on the surface but might discharge metals to groundwater and interflow. Many source discharges can form salts, which in turn become sources of intense metal loading when re-exposed to moisture.

Numerous field investigations have been conducted to characterize these IMM area source discharges and to define the sources related to the discharges. Some specific sources of the AMD discharges have been identified. However, although extensive efforts have been undertaken over the past several years, the majority of the sources of the area source discharges have not been identified. It has been possible to identify an approximate 150-acre area, disturbed by extensive mining efforts, as the area source of essentially all of the Slickrock Creek heavy metal and acidity discharges. See Photo Exhibit 1. Similarly, it has been possible to define an approximate 1,000-foot reach of Boulder Creek adjacent to an area used for extensive mining activities as the area in which 50 to 70 percent of the Boulder Creek area source discharges enter the creek.

Slickrock Creek and Boulder Creek serve as collection points for contaminated groundwater, interflow, and surface water for area sources in the respective watersheds.

The discharges from the area sources are closely associated with heavy rainfall and high runoff storm events. Remedies that are effective at low flow (such as treating baseflows of Slickrock Creek) become significantly less effective as flows increase, which are the time periods when the Site produces the largest releases of hazardous substances.

Releases of arsenic from the several hematite mine processing piles also pose a potential threat to public health and the environment. The piles are actively eroding into state waters and result in arsenic being released into the environment. For example, the arsenic-laden sediments deposited in Spring Creek Reservoir result in exposure of maintenance workers to levels of arsenic in ambient air that exceed safe levels for workers under OSHA requirements.

Contamination of the Watersheds above SCDD

The receiving waters upstream of the SCDD impacted by releases from IMM are essentially devoid of aquatic life as a result of releases of hazardous substances from the Site (and in the case of Spring Creek, in small part due to the release of metals from the Stowell Mine). The sources of the ongoing contamination include the current AMD releases, contaminated sediments, eroded mine tailings and wastes from past mining activities, and current releases of tailings and mine wastes into surface waters. In contrast, the reaches of these streams upstream of past mining activities support abundant aquatic life.

Contamination Downstream of SCDD

The fishery resources and other sensitive aquatic species in Keswick Reservoir and in the Sacramento River (below Keswick Dam) are the primary natural resources currently at risk because of the continuing uncontrolled IMM heavy metal discharges. The IMM releases contribute to the risks to species in this area by causing the acute exceedance of water quality standards, by exposing aquatic resources to long-term sub-lethal metal levels, and by exposing aquatic resources and benthic organisms to toxic precipitates and heavy metal-laden sediments.

The SCR controls the rate at which IMM AMD is released into Keswick Reservoir and the Sacramento River. The USBR meters the highly polluted IMM AMD into the Sacramento River to permit dilution of the IMM AMD using large volumes of CVP waters. The USBR operates the SCDD in accordance with a 1980 Memorandum of Understanding (MOU), which contains interim operational targets for heavy metals below Keswick Dam. These interim operational targets are intended to provide safe releases of IMM AMD to the extent possible in light of the intense hydrology of the Spring Creek watershed and the very large metal loads released by IMM.

Because of the high pollution loads generated by IMM, water must often be released from SCR at a slow rate to ensure appropriate dilution. This slow release rate can cause the SCR to become full in relatively short periods of time (i.e., several days). Once the capacity of SCR is exceeded, SCR water spills into Keswick Reservoir in an uncontrolled manner (or just prior to a spill, SCR water is otherwise released using emergency release procedures) for periods lasting from a few hours to, more commonly, several days or weeks. Spills from the SCR (and to a slightly lesser extent SCR releases during emergency release procedures) cause exceedances of the SBPS and PCTR in areas of Keswick Reservoir and, in almost all cases, exceedances below Keswick Dam. If the USBR were to operate the SCDD in a manner to achieve more stringent standards below Keswick Dam, the SCR would need to release water more slowly, which in turn would cause the SCR to fill and spill more often. For these reasons, the 1980 MOU recognizes that without extensive controls in place at Iron Mountain, the USBR cannot operate the SCDD in a manner that will be able to ensure compliance with fully protective standards. EPA modeling indicates that in the absence of further remediation, SCDD spills and corresponding exceedances of the SBPS below Keswick Reservoir are expected to occur on average every 2 to 3 years if the SCDD is operated to achieve the SBPS below Keswick Dam. Operating the SCDD to meet the recently proposed PCTR (below Keswick Dam) would cause the spills to occur every 2 to 3 years on average. Spills would occur even more frequently if the SCR were operated to target compliance with these standards in Keswick Reservoir rather than downstream of Keswick Dam.

The flows in the Sacramento River available at the onset of major early season storm events cannot generally provide adequate dilution of the IMM contaminants at current levels of metals discharges. The EPA has performed an analysis of the hydrologic and water quality factors and has calculated the Sacramento River flow required to ensure the dilution of IMM-contaminated SCR waters to meet water quality standards. During storms in 1995 and 1996, SCR waters, with full treatment of the three major mine discharges, exhibited levels of contamination of 400 to 800 ppb dissolved copper (compared to the SBPS of 5.6 ppb copper at hardness of 40 ppm). The SCR water contains similarly high levels of cadmium and zinc. Storm inflows into the SCR are frequently observed at several hundred to 1,000 cfs. Sacramento River flows are frequently near minimum legal flows during the first storm of the season, or are not generally more than 10,000 cfs.

Events in 1995 provide a good illustration of the types of conditions that present acute risks to the aquatic organisms downstream of the Site. During the January 1995 storms, IMM metal discharges were the source of greater than 90 percent of the Keswick Reservoir metal loads. During that period, a large volume of untreated AMD was released from the Site into the Sacramento River for a period of several weeks. This continuous release of untreated AMD from the Site caused the SBPS to be exceeded in the main stem of the Sacramento River continuously from January 9, 1995, through January 27, 1995. At times during the storm event, copper concentrations were more than twice the levels considered safe under the SBPS and the PCTR. For more information on this issue, see Section 2.3.2.3 of the Water Management Feasibility Study Addendum and reports referenced therein.

During the January 1995 storm event, metal concentrations in the Sacramento River were elevated to levels that are clearly toxic to fish and other aquatic organisms. For example, based on the toxicity testing recently completed by Hagler-Bailly (Hagler-Bailly, 1996), the copper concentrations in the Sacramento River were measured at or near the 96-hour LC50 for rainbow trout fry in the low pH and low alkalinity waters observed during the January 1995 spill. (The LC50 is the concentration of a toxic constituent [in this case, copper] that would result in the mortality of fifty percent of the test organisms [in this case, rainbow trout fry] within a specified time period [in this case, 96 hours]). The LC50 established for rainbow trout in the Hagler-Bailly testing is also applicable with respect to establishing the toxic effects of the elevated January 1995 metal concentrations on the valuable Sacramento River salmon fishery. Additional California RWQCB toxicity testing (RWQCB, 1997) has shown that copper concentrations much lower than the observed conditions of the 1995 spill are toxic to algae, an important element of the Sacramento River ecosystem. For example, RWQCB tests indicate that copper concentrations at or near the current SBPS (5.6 ppb copper at a hardness of 40 mg/l as $CaCO_3$) can be toxic to algae, while concentrations during the January 1995 storm were well above those levels.

EPA's modeling analyses indicate the following:

- Under current conditions, with treatment of the three major IMM sources, SCDD spills of contaminated waters would be expected to occur regularly, even assuming that USBR would always be able to perfectly define the appropriate releases during highly variable storm conditions. Using a more realistic estimate of SCR operations would increase the frequency of the predicted exceedances. Site releases also continue to affect natural resources below the SCDD by discharging large loads of heavy metals which form precipitates that contaminate downstream sediments.

- The two most important factors which currently make it impossible for SCDD to permit dilution of IMM AMD in a manner that maintains the SBPS below Keswick Dam in the Sacramento River are: (1) the storm inflows to the SCR are highly contaminated, and (2) storms that cause these contaminated waters to fill the reservoir within a few days will likely occur every 5 to 10 years. More frequent SCDD spills (on the order of one spill every 3 to 4 years) will occur as a result of other factors such as preceding drought conditions that will limit the flow in the Sacramento River. Spills would occur more frequently if the SCR were operated to target compliance with a more stringent standard or at a point in Keswick Reservoir closer to the SCDD.

- Significant further remediation of the IMM area source discharges, such as reducing dissolved copper concentrations in SCR to 100 ppb or less, is required to ensure that continued operations of SCDD would be able to safely release any continuing uncontrolled IMM discharges to protect the Sacramento River below Keswick Dam. Additional controls would be needed to fully restore the Keswick Reservoir aquatic ecosystem.

V.2 Location of Contamination and Known or Potential Migration Routes

The major mechanism for onsite and offsite transport of contaminants is surface water. The AMD enters Boulder and Slickrock Creeks, and these two creeks discharge into Spring Creek, which flows to the Sacramento River at Keswick Reservoir.

The contaminants of concern can be biologically transported through the aquatic food chain. For example, the initial uptake of contaminants would be by phytoplankton, periphyton, and other aquatic vegetation. These food sources would be ingested by benthic invertebrates and/or zooplankton. The plankton and benthos would be ingested by fish at subsequently higher trophic levels and ultimately consumed by birds, animals, and humans.

The major processes that affect the fate and transport of copper, cadmium, and zinc are coprecipitation with iron hydroxides and precipitation as carbonates. As Spring Creek discharges into the main body of Keswick Reservoir, IMM AMD mixes with water from Keswick Reservoir, which dilutes the SCR waters and increases the pH of those waters. These processes reduce the concentration of dissolved metals but also generate significant volumes of metal precipitates, some of which become river sediment while another portion continues to remain suspended in the water column as the water moves down river. Under current conditions, IMM AMD causes approximately 5 to 15 tons of copper to precipitate into State waters in normal and wet years. In addition, the acidic releases from Iron Mountain introduce cadmium, zinc, and iron precipitants into state waters.

Above the SCDD

The IMM AMD drains to Boulder Creek and Slickrock Creek, which in turn flow into Spring Creek and the SCR. For combined distance of several miles, these receiving waters are essentially devoid of aquatic life as a result of hazardous substance releases from the Site. Releases from the Site also continue to severely impair the habitat of non-aquatic species, particularly amphibians and other species heavily dependent on aquatic resources. Mining-related contaminated sediments also exist in these water bodies, although their current impact is overshadowed by the extreme acidity and metal loads in the surface water.

Below the SCDD

The IMM AMD releases pass through the SCR and Keswick Reservoir and into the main body of the Sacramento River. The USBR operates the SCR in a manner that reduces the concentration of IMM AMD by metering in the SCR water into the Sacramento River flows in Keswick Reservoir. However, even with implementation of the highly effective interim IMM treatment remedial action, the SCR operations continue to be unable to meet either the MOU release schedule for total metals or the SBPS for soluble metals. The inability to maintain the appropriate release schedule and SBPS compliance arises from the large metal loads generated by IMM AMD and the intense hydrology of the Spring Creek watershed. If the SCDD were operated to comply with the PCTR, the frequency and duration of SCDD spills would increase even further because the SCR would have to be released a slower rate to permit the dilution needed to comply with the more stringent criteria. This slower release rate would cause the SCR to fill and spill more often during storm periods.

Other factors also exacerbate the toxicity posed by uncontrolled AMD discharges below the SCDD. The types of storm events that tend to cause uncontrolled spills from the SCDD also tend to create the most difficult periods of SCDD operations and a depression of the hardness in the Sacramento River. As water hardness decreases, metals become more toxic to aquatic resources. Factoring the more difficult operations and the influence of hardness on water quality criteria would therefore tend to compound the difference between the modeled and current SCDD operations. These factors seriously impede USBR's efforts to operate the SCDD in a manner that would be necessary to comply with the SBPS and otherwise maintain fully protective conditions below the SCDD.

The most significant hydrologic conditions related to operating the SCDD in a manner that controls the continuing IMM AMD discharges (or spills) are the combination of low releases from Shasta Lake and high inflows of highly contaminated waters into the SCR. The low releases from Shasta Lake typically occur when Shasta Lake storage is low after one or more years of dry conditions. In such conditions, USBR operations criteria specify that water should be stored for beneficial uses rather than released above certain minimum flows. Shasta Lake storage capacity is approximately 4.55 million acre-feet, with non-usable storage of about 116,000 acre-feet.

When the Sacramento River flow is low, it is very difficult to safely discharge highly contaminated waters from the SCR because, due to the highly contaminated IMM AMD discharges, significant dilution is necessary to meet the water quality criteria below Keswick Dam. The inability to release significant amounts of contaminated water from the SCR is a critical factor with respect to the problem of high inflows to SCR during storm events. The SCR can fill in a few days during high runoff events. Large storm events with several thousand acre-feet of inflow can cause an uncontrolled spill of contaminated waters within a few days. Prolonged storm events combined with antecedent drought conditions can cause the SCDD to spill for extended periods of time. For example, the SCDD spill in 1992 and 1993 lasted for several weeks and resulted in prolonged exposure of aquatic resources to toxic levels of heavy metals.

All of the six largest storm events since 1955 have occurred in December or January. Historically, most releases from Shasta Lake and Whiskeytown Reservoir in these months total less than 10,000 cfs. Relatively low winter flows particularly at the beginning of the wet season are expected in future years due to current and future water demand and other CVP operational constraints.

The competing demands for fresh water in California for domestic, environmental, agriculture and industrial use are expected to constrain these flows further in future years. Although water availability from one to the next is uncertain, particularly considering the time-period that IMM is expected to continue generated large volumes of hazardous substances, recently acquired information indicates that less Sacramento River water could be available in future water years. For example, the United States Department of Interior, the agency responsible for CVP operations, is currently considering whether to hold more water during the winter months to permit greater flows at other times of the year to protect endangered species. These storage requirements would reduce the available storage capacity of Shasta Lake and the available dilution water for IMM pollution. Other CVP operations being considered by the U.S. Department of Interior would reduce the release of water during high flow periods, which in turn would reduce the water available to dilute IMM AMD.

Other statutes and programs could also affect the flows in the Sacramento River. The available information regarding two such programs, the Central Valley Project Improvement Act (CVPIA) and the Bay-Delta Accord, indicates that those programs are unlikely to have a significant impact on releases from Shasta Lake in December or January, the two months during which the six major storm events since 1955 occurred. Higher release requirements might occur in the spring months through June, but these releases would typically not benefit the IMM response action because SCDD spills typically occur in the early winter months. Additionally, the future diversion of Trinity River flows to the Sacramento River via the Spring Creek Power House is likely to be significantly reduced as the result of efforts to restore the Trinity River ecosystem. The reduced availability of these waters, that have in the past been relied on to dilute the IMM heavy metal releases, would necessitate further remedial action and control of the IMM discharges.

VI. SUMMARY OF SITE RISKS

VI.1 General

The IMM Superfund Site was placed on the National Priorities List on September 8, 1983. The Site was listed because of the impacts of metals-laden AMD discharges on the Sacramento River, which supports a major fishery and which also serves as a source of drinking water and other domestic water supplies for the City of Redding. Throughout much of its history, the Iron Mountain Site has been associated with water quality degradation and impacts on aquatic resources in nearby drainages. Impacts include numerous fish kills in the upper Sacramento River (at least 39 documented fish kills since 1940), the primary salmon-producing river in California (CDWR, 1985; CDFG, 1990). For more detailed information regarding these risks, see the Public Comment Environmental Endangerment Assessment (May 1992) and the Human Health Risk Assessment (May 1991), as well as other documents in the Administrative Record.

Although EPA Superfund response activities currently control 80 to 90 percent of the IMM AMD releases, hazardous substance releases from the Site continue to pose serious environmental risks. The portions of Boulder Creek, Slickrock Creek, and Spring Creek that receive AMD from Iron Mountain continue to be essentially devoid of aquatic life. During storm periods, the continuing IMM AMD releases constitute the vast majority (more than 90 percent in the January 1995 storm) of metal loading to Keswick Reservoir. Even if the SBPS are met, IMM AMD releases continue to impair water quality through the discharge of large heavy metal loads, a portion of which form precipitates as heavy metal-laden sediments that contaminate the streambed in Keswick Reservoir on an almost continuous basis. In the main stem of the Sacramento River, current IMM AMD releases are expected to cause exceedances of the SBPS and the PCTR on a regular basis. The IMM AMD continues to cause an average of 5 to 15 tons per year of copper precipitates in Keswick Reservoir and the Sacramento River in normal to wet years. For comparison, Iron Mountain currently discharges to State waters an annual average of 80 to 240 pounds of copper per day, which is roughly one to three times the average daily copper discharge of all of the regulated industrial discharges to the entire Sacramento River, San Francisco Bay and Delta.

VI.2 Human Health Risks

Persons who might come into direct contact with or consume concentrated AMD at Iron Mountain could be at risk. Such persons include people working, living, or hiking at the Site. Individuals who enter the Iron Mountain Site are at risk if they have direct contact with or ingest the AMD. The risk of such exposure is currently limited by controlled access to the minesite. The property owner has posted the property to discourage trespassers. The property is located between two heavily used national forests, so direct exposure is clearly possible.

Persons who might come into direct contact with surface water downstream from Iron Mountain include people working, living, hiking, or swimming near the Site. Individuals who come in direct contact with water from the main body of Keswick Reservoir or Sacramento River are not currently at risk.

Persons who might consume surface water downstream from Iron Mountain include people working, living, or hiking near the Site.

Persons who might consume fish taken from the Sacramento River downstream from Iron Mountain include the general population in the upper Sacramento River Valley. Tissue samples from fish inhabiting this area have some of the highest metal levels of anywhere in the State. Individuals who consume fish from the main body of Keswick Reservoir or Sacramento River may currently be at some risk, but the risk has not been quantified.

Children are at somewhat greater risk than adults when considering noncancer toxicity resulting from incidental ingestion of affected creek water downstream from Iron Mountain.

Although an arsenic pathway has not been studied extensively, USBR workers measured arsenic levels in excess of safe worker exposure levels while conducting maintenance on the SCDD. The most likely source of this arsenic is the arsenic-laden hematite piles in the Slickrock Creek watershed, which have been actively eroding into Slickrock Creek for several decades.

VI.3 Environmental Risks

The principal risks posed by the runoff of metals-bearing AMD from Iron Mountain are the associated impacts on aquatic life in the Spring Creek drainage, Keswick Reservoir, and the Sacramento River downstream of Keswick Dam. Among these natural resources, the most important are the fishery resources in the Sacramento River downstream of Keswick Dam. Migratory populations of chinook salmon, steelhead trout, resident trout, and numerous other aquatic and terrestrial species, can be or are affected by AMD from Iron Mountain.

Fishery Resources below SCDD

The salmon and steelhead trout populations have high commercial and/or recreational value to the region. The susceptibility of these populations to contaminants originating from Iron Mountain has been well documented (Wilson, 1982; Finlayson, 1989 and 1995; Hagler-Bailly 1996). One of the chinook salmon runs, the winter-run, is a species listed by the Federal and State Governments as endangered. The steelhead in this region are currently being considered for listing as an endangered species under the federal Endangered Species Act. The spring-run salmon is a candidate species under the State Endangered Species Act.

Pollution from Iron Mountain is considered to be a major factor causing the decline in Sacramento River fishery resources and impeding fishery resource restoration goals. Other major factors contributing to the fishery decline include loss of spawning habitat, predation, habitat degradation, mortality at dams and diversions, overfishing, and natural disasters (such as drought) (Vogel, 1989). Fish migrating into the uppermost reach of the Sacramento River risk being killed by AMD from Iron Mountain; offspring of adult fish spawning in that reach have reduced chances of survival because of the Iron Mountain AMD (Finlayson and Wilson, 1979). There is an indication that AMD from Iron Mountain has reduced the suitability of available spawning grounds for salmon in the uppermost reaches of the Sacramento River and that fish population reductions have occurred following uncontrolled spillage of Iron Mountain AMD (Finlayson, 1979). The greatest decline in salmon-spawning populations has occurred within the uppermost river reach from Balls Ferry upstream to Redding, a distance of approximately 26 river miles (NOAA, 1989). Sub-lethal exposure to toxic metals can also adversely affect exposed species.

Fish counts were initiated at Red Bluff Diversion Dam in the late 1960s. The fish counts document major declines in each of the anadromous salmonid runs. A more extensive data base is available specifically for fall-run salmon. This data base demonstrates that recent levels of spawning escapement to the upper Sacramento River are only about 50 percent of levels observed during the late 1950s. The greatest decline among the salmon runs has occurred for the winter-run, which has been reduced to less than 5 percent of run sizes during the late 1960s. This serious decline prompted the 1989 listing of this fish as a threatened species by the Federal Government (NMFS, 1989) and an endangered species by the State of California (CDFG, 1989). The Federal Government subsequently reclassified the winter-run as an endangered species.

Currently, the fisheries populations with the greatest potential exposure include the salmonids and steelhead trout present in the Sacramento River below Keswick Dam. The upper Sacramento River chinook salmon runs, steelhead trout run, and resident populations of rainbow trout have life history characteristics that make them vulnerable to potentially adverse effects from AMD originating from IMM. The probability and magnitude of potential exposure depends on the releases of contaminated water from SCDD, the releases of water from Shasta Lake and Whiskeytown Reservoir, and the life stages of fish present within the zone of impact.

For spring- and fall-run chinook salmon, in a worst-case scenario, approximately half of an entire year's spawning production could be at risk from contaminants released from Iron Mountain. The impact of the release depends in large part on the pattern of releases from Shasta Lake and Whiskeytown Reservoir relative to when releases occur from IMM. For example, flood control releases from Shasta Lake could cause most of the year's production to migrate downstream of the affected water quality zone, thereby reducing the AMD's impact.

Under certain circumstances, the endangered winter-run chinook salmon could be at higher risk compared to other runs. That run is most likely to seek cooler water in areas closest to Keswick Dam because of potentially lethal water temperatures in lower reaches of the Sacramento River. Under drought-type conditions, these fish are the most important to future runs because eggs laid further downstream are more likely to be adversely affected by lethal warm water temperatures. However, these same drought conditions are more likely to create conditions (low water flows in the Sacramento River) where AMD from IMM could pose a high risk to juvenile rearing in the uppermost reach of the river. While winter run salmon do not spawn during the period that is most likely to experience an SCDD spill, a spill during the winter run spawning period is not impossible. More importantly, juvenile salmon are generally present in the Sacramento River below Keswick Dam during December and January, when a spill is most likely. Although juvenile salmon are more tolerant of copper and zinc concentrations than eggs and fry, the juvenile salmon could be impacted by IMM contaminant spills during the December and January time period.

The steelhead trout and resident rainbow trout populations that are potentially at risk are not well-defined or understood. However, both the adult and yearling life stages are potentially at risk because both are present in the river when fish kills have historically occurred.

At present, the USBR operates the SCDD pursuant to an MOU. Pursuant to that MOU, USBR operates the SCDD in a manner that (when considering releases of waters from CVP facilities, including Shasta Lake, Whiskeytown Reservoir, and Keswick Dam) will meet operation criteria for control of metal concentrations in the Sacramento River intended to protect aquatic life in the Sacramento River downstream of Keswick Dam, taking into consideration the extreme releases from the Site and provided such operations would not (1) cause flood control parameters on the Sacramento River to be exceeded, or (2) interfere unreasonably with other project requirements.

The USBR must also operate Shasta Dam to provide electric power, irrigation water, and flood control. The USBR estimated that it would incur significant losses of revenues, depending on the level of protection required in the Sacramento River, if special releases of CVP waters continue to be relied on for purposes of diluting IMM contaminant discharges. There is the potential that USBR's ability to supply adequate dilution water will be further reduced because of conflicting priorities for water use, thereby increasing the potential risk to the aquatic community. It is also important to note that the operational parameters of the 1980 MOU approximate the SBPS below Keswick Dam but do not assure compliance at that location under all circumstances. For example, the 1980 MOU is based on an assumption that 50 percent of the dissolved metals will form precipitates in Keswick Reservoir. More recent and detailed studies by EPA indicate that the precipitation rate is more appropriately estimated at 35 percent under most conditions. Operation of the SCDD in conformance with the 1980 MOU will therefore still result in exceedances of the SBPS (even without taking into account hydrologic events requiring emergency SCDD releases or causing uncontrolled spills).

It is extremely difficult to quantify fish mortality in the Sacramento River as a result of contamination from IMM. This is due to a variety of factors, including the general size of the Sacramento River downstream of Keswick Reservoir and the difficulty of visually observing dying or dead fish during periods when the water is turbid. However, there have been 39 documented fish kills near Redding since 1940, and since the installation of the SCDD in 1963, there have been observations of adult steelhead mortalities near Redding attributable to metal contamination from IMM.

The current mass loading of metals from IMM also exposes aquatic resources to sub-lethal metal levels. For example, metal concentrations in Keswick Reservoir and below Keswick Dam regularly exceed the recently proposed chronic water quality criteria for copper, indicating species in those waters are at risk with respect to chronic exposure to copper. Fish in the area contain some of the highest levels of metals of any fish in the State. In addition, because the SBPS are stated in terms of dissolved and not total metal concentrations, the standards do not protect fish from the effects of exposure to the non-dissolved fraction of total metal concentrations. While the non-dissolved fraction is less toxic than the dissolved fraction, long-term exposure to total metal concentrations is also known to pose risks to exposed organisms.

Environmental Impacts above the SCDD

The environmental effects are even more severe upstream of the SCDD. The waters receiving IMM AMD upstream of the SCDD (Boulder Creek, Slickrock Creek, and Spring Creek) are currently devoid of fish and aquatic invertebrates. These creeks may remain sterile following current remediation activities at Iron Mountain. Whether reaches of those creeks could be restored to a degree that would support aquatic life or other beneficial uses is currently unknown. Implementation of this interim action and the ongoing study of further action from Boulder Creek area sources will enhance EPA's understanding of the feasibility and appropriateness of taking additional response actions to further address those impacts.

Water Column and Benthic Organisms

Past and current IMM AMD releases also pose a risk to water column and benthic aquatic populations in Keswick Reservoir downstream of Spring Creek. IMM AMD releases have caused and continue to cause the contamination of the water column and stream or reservoir sediments. Below Keswick Dam, contaminant concentrations in the water column occasionally exceed toxic concentrations for sensitive life stages and frequently exceed both EPA and State of California criteria to protect aquatic life, indicating that benthic and water column populations are at risk. The formation of heavy metal precipitates as the AMD releases are diluted poses threats to benthic organisms through smothering as the precipitates settle and through chemical toxicity. Benthic survey information indicates that benthic populations are severely reduced or absent from areas where extensive heavy metal-laden sediments are present in the Spring Creek arm of Keswick Reservoir and in the main body of Keswick Reservoir. The streams above SCDD influenced by IMM are currently essentially devoid of aquatic life.

Terrestrial Wildlife

IMM AMD releases also have the potential to adversely affect onsite terrestrial wildlife. More than 300 species of amphibians, reptiles, birds, and mammals can be expected to occur in the Boulder Creek and Slickrock Creek basins and downstream areas. These species can be directly exposed to AMD. For example, deer can drink from contaminated creeks, lick metals-laden salts along the flume system, or consume contaminated plants or other organisms. AMD has severely impacted the habitat and food sources for species heavily dependent on aquatic resources, such as amphibians. In the absence of hazardous substance contamination, the area could provide habitat for a host of special-status and other species.

VII. DESCRIPTION OF ALTERNATIVES

VII.1 General

Consistent with the NCP, EPA has developed remedial action objectives to assist the Agency in studying remedial alternatives. 40 CFR § 300.430(e)(2)(i). The overall remedial action objective at the Site is to eliminate IMM Site discharges that are harmful to the environment. The EPA has also identified three primary goals for the IMM Superfund remedial action:

1. Comply with the water quality criteria established under the Clean Water Act.

2. Reduce the mass discharge of toxic heavy metals through application of appropriate control technologies.

3. Minimize the need to rely on special releases of California's valuable water resources to ensure compliance with water quality standards in the Sacramento River through special releases of waters to dilute toxic spills of IMM contaminants.

The contaminants of concern identified in the 1986 ROD are acidity and toxic metals, which include copper, cadmium, and zinc. All of these are present in AMD from Slickrock Creek area sources. Arsenic is an additional contaminant of concern that has been identified with respect to the large hematite pile that is actively eroding into Slickrock Creek and downstream areas. The arsenic in the hematite pile exceeds the total threshold limit criteria (TTLC) established by the State of California. The high arsenic concentrations that are present in this waste pile pose a threat to human health and the environment.

VII.2 Technology Screening Evaluation

The technology screening phase of the feasibility study consists of a two-step process. The first step involves identifying general response actions that could potentially meet the remedial action objectives for the sources being addressed. The second step involves analyzing and comparing technologies and process options that EPA has determined are appropriate for consideration.

The EPA determined that the Site conditions restrict the number of alternatives to four general types of response actions:

1. No-Action—No further actions would be implemented as part of the EPA Superfund cleanup action at the Site.

2. Source Control Response Actions—Prevent AMD formation through isolation of water and/or air from the sulfide rock.

3. Treatment Response Actions—Collect and treat the AMD, dispose of the treatment residuals (sludge), and discharge the treated water.

4. Water Management Response Actions—These options include surface-water diversions of clean water flows and construction of dams to contain the contaminated flows until they can be treated or safely released.

The EPA then refined the range of alternatives within each category by first evaluating whether the alternative was technically implementable at this Site. If an option was not technically implementable, the option was eliminated from further consideration. The EPA then evaluated the remaining options more closely to determine the options and technologies to be developed into remedial alternatives. This selection is made by comparing the options on the basis of implementability and effectiveness, with implementability being the more important criterion during the screening process.

Following is a brief summary of the screening evaluation.

VII.2.1 No Further Action

In accordance with the NCP, EPA evaluated the No Further Action alternative in detail.

VII.2.2 Source Control Response Actions

Source control response actions involve source-specific responses for individual AMD sources. Potential source control response actions include groundwater control, capping, surface controls, removal of waste piles and sediments, and resource recovery. For purposes of clarity, this document refers separately to source controls that prevent AMD formation and general collect and treat technologies. Certain other documents refer to these non-water management technologies as "source control" remedies.

An EPA review of the types of sources being addressed in Slickrock Creek indicated that a source-specific approach would be difficult to implement, and even if feasible, would likely be less cost-effective than a general collect and treat approach. In general, the Slickrock Creek area sources are difficult to identify and characterize. The sources are spread throughout the Slickrock Creek basin in the vicinity of areas affected by intense mining activity. Many of the sources, such as the mine workings and mineralization exposed through changes in hydrology, are belowground and/or buried below the large debris slide. Despite Rhone-Poulenc's best efforts to locate buried mine portals during the past 2 or 3 years, it has not been able to locate buried mine workings with AMD. The presence of millions of cubic yards of mine overburden and other materials over the mine workings severely impedes the identification of these sources. Even if the workings are identified, one would need to develop a reliable strategy for responding to releases associated with that source.

With respect to some of the more significant area sources that are readily identifiable, the most effective remedial strategy appears to involve a general collect and treat approach. For example, the large debris slide is a source of mining-related hazardous substance releases. The debris slide contains millions of cubic yards of materials so that excavation and consolidation would be very difficult and prohibitively costly to implement. In addition, removal or consolidation of the debris slide would likely increase the exposure of the underlying sulfides to oxygen and water, thereby increasing the release of AMD. Source control of disturbed mineralization would likely be even more difficult because the areas are widespread and not easily accessible. These factors suggest that general collect and treat approaches would be more effective and cost-effective than source-specific type approaches.

Source Control by Groundwater Control

Source control by groundwater control involves reducing or eliminating groundwater contact with sulfide rock by blocking lateral groundwater flow with a barrier or intercepting the flow with an active well-dewatering system. Since this technique is not effective in broken ground located above and around mine workings and around waste piles prevalent in the target area, the approach cannot be used as a primary response action for these sources. The EPA also reviewed and rejected as not practical or effective the use of pressure grouting to control seep flow.

Source Control by Capping

Capping involves placing a cap in a manner that reduces the inflow of fresh water to the acid-forming zones. The feasibility of this approach depends on the feasibility of placing an impervious cover above the source, the practicality of maintaining the cover during the life of the project, and the proportion of water actually diverted from the sites of reaction. While this strategy is implementable and could potentially be used with respect to a few sources, the approach is not a practical means to control Slickrock Creek area sources generally due to the very large area over which AMD-forming reactions appear to be occurring, the steep terrain in those areas, and the potential for landslides and the continued movement of the waste materials and debris to be capped.

Source Control by Surface Controls

Source control by surface drainage controls involves routing surface water away from waste piles and disturbed areas through the use of grading and diversions. While this strategy is implementable and could potentially be used with respect to a few sources, the approach is not a practical means to control Slickrock Creek area sources generally. The Slickrock Creek area sources cover an area of approximately 150 acres. Extensive surface water diversions would be required to prevent surface water from entering this source area. However, these surface controls would not prevent rainfall from falling directly onto these area sources resulting in AMD formation and discharge. The approach is unlikely to obviate the need for a general collection approach. Surface water controls may be useful in controlling specific areas in future actions at IMM.

Source Control by Removal of Waste Piles

Excavation and consolidation of waste piles, contaminated soils, debris, and/or sediments, is considered to be impracticable for the Slickrock Creek area sources in general. The amount of material present in the debris slide and other contaminated areas is too extensive to make this approach feasible for general remediation of the Slickrock Creek area sources. The steep and difficult terrain would also make this approach difficult to implement throughout the basin. In addition, removal of the debris slide might increase the exposure of sulfides and therefore exacerbate the release of hazardous substances. The approach is also unlikely to be cost-effective relative to a general collect and treat approach. However, removal of specific waste piles may be appropriate in a final remedy for the Site. Also, removal of contaminated sediments, although very difficult, may be necessary as part of the Site remedy to achieve ARARs compliance.

Source Control by Resource Recovery for Waste Piles

EPA also evaluated several resource recovery treatment options that could be used to recover certain metals from some of the waste piles. These options include flotation (a historic treatment method for ore) or soil washing (such as acid leaching, which has been also used to treat ore). The removal efficiencies of these processes are expected to be low because the in situ metals concentration in piles is relatively low, and the metals are likely to be present primarily as insoluble sulfides. The implementability and effectiveness of these treatment options cannot be currently evaluated, but the available information does not establish that this current technology would permit this approach to be cost-effective or implementable at this time. Laboratory or bench-scale testing is required to provide sufficient information to conduct more detailed assessments. Because of the lack of demonstrated effectiveness, EPA dropped these alternatives from further consideration in the analysis.

VII.2.3 Collection of Seeps and Surface Water

The EPA also considered the feasibility of collecting and treating seeps using groundwater extraction systems, such as wells or drains. This approach could be implemented in combination with treatment of portal discharges at the IMM HDS treatment plant currently in operation. There are technical and cost limitations concerning the treatment of seeps because of the expected small flow rates and metals loads from these sources and because access to some of the seeps will be difficult. The EPA eliminated this approach from further consideration in the FSA because of its limited effectiveness for the dispersed Slickrock Creek AMD discharges.

The EPA considered the feasibility of collecting and treating contaminated tributary flows and treating those flows at the existing IMM HDS treatment plant. There are technical and cost limitations concerning the collection and treatment of contaminated surface waters because of the large volumes of contaminated runoff associated with storm events that may require treatment and because of the dilute nature of these flows. The presence of the existing HDS neutralization treatment plant and its ongoing operations significantly enhances the implementability and cost-effectiveness of this approach. Collection systems for surface-water collection and treatment approaches would include surface-water diversions to ensure collection of contaminated surface waters from remote contaminated areas and retention basins and to regulate their discharge to a treatment plant. The surface-water collection technologies were retained for further study in the FSA.

VII.2.4 Treatment Response Actions

Treatment was considered both as a stand-alone response action and in combination with other technologies to form combined alternatives. The HDS neutralization/precipitation of AMD is considered the primary treatment option on the basis of past studies. The HDS treatment process was selected in ROD2 and ROD3 for IMM. The reliance on the HDS process is expected to provide significant benefit for the treatment of the dilute Slickrock Creek area source AMD discharges. The full-scale IMM HDS treatment plant became operational at IMM in January 1997.

In-stream treatment, cementation, membrane processes, ion exchange, and passive treatment were dropped because of their expected limited effectiveness or because they were not implementable. Mechanical evaporation, liquid-liquid extraction, and biological treatment were retained for further consideration as secondary treatment options.

Disposal options were studied because all primary treatment options generate a sludge that requires disposal. RCRA landfills were not considered because past IMM RODs concluded that a non-RCRA sludge disposal option is the preferred technology. A non-RCRA landfill is currently in operation at IMM at Brick Flat Pit. Treatment of the Slickrock Creek area source AMD discharges is not expected to change the nature of the treatment sludges or disposal requirements. The EPA has concluded that the non-RCRA sludge disposal technology would be effective, implementable, and cost-effective. Sequential modifications could be made to the Brick Flat Pit sludge disposal facility to enable sufficient storage capacity for sludge disposal for 50, 100, or several hundred years, depending on the volume of AMD treated and the characteristics of the sludge produced. The Brick Flat Pit non-RCRA sludge disposal option was retained for further consideration.

The additional treatment plant effluent resulting from treatment of the Slickrock Creek area source discharges could be discharged either onsite to Spring Creek, Boulder Creek, or Slickrock Creek, or offsite to the Sacramento River. The IMM treatment plant currently discharges to Spring Creek by a pipeline. The larger volumes of effluent will require the construction of additional facilities such as a gravity tunnel or an additional pipeline. The EPA dropped from consideration an alternative involving piping the discharge to the Sacramento

River because the option would be more costly to implement but did not provide any additional benefit over the Spring Creek discharge option. The EPA retained discharge of the treatment plant effluent to Spring Creek.

VII.2.5 Water Management Response Actions

Water management response actions include surface-water diversions of clean water flows and construction of dams to contain the contaminated flows until they can be treated or safely released. These response actions could be implemented to meet several distinct project objectives: (1) divert clean waters away from contaminated areas to reduce AMD-forming reactions; (2) increase the effectiveness of treatment approaches by diverting clean flows away from the collection basin; and (3) provide capability to manage releases of contaminants to surface waters that cannot be feasibly controlled to ensure protection of human health and the environment.

Surface Diversion

The intent of surface-water diversions for water management remedial approaches is to divert less contaminated surface-water flows around AMD containment basins. The diversion of less contaminated waters can be accomplished by a variety of methods. Clean-water diversions were retained for further consideration as they can be designed to perform effectively in combination with other technologies, and offer the opportunity to develop more cost-effective remedial approaches.

Containment Dams

Containment dams create reservoirs (basins) for storage of contaminated waters until the water can be safely released or treated.

The SCDD could be enlarged to provide additional storage capacity for the contaminated Spring Creek watershed inflows. The existing SCDD establishes a 5,016-acre-foot reservoir to contain IMM-contaminated waters. Although the existing SCR provides some protection to the environment, it is undersized to allow for full protection in the absence of additional remedial alternatives beyond the No-Action Alternative. An enlarged reservoir would be needed for storage of the IMM-contaminated waters to permit the water to be released in accordance with protective water quality criteria.

Under an alternate approach, new dams could be built in Boulder Creek, Slickrock Creek, and/or Spring Creek above SCR to establish new reservoirs. These alternate reservoirs could be relied on as storage reservoirs in conjunction with the existing SCR.

Under a third approach, potential onsite containment basins would be relied on in combination with treatment remedial action components to ensure treatment of the contaminated waters contained by the dams. Studies indicate that control and treatment of the Slickrock Creek area source AMD discharges are consistent with viable remedial strategies for the Site that could be effective and cost-effective.

Containment dams were retained for further consideration as they can be designed to perform effectively in combination with other technologies, and offer the opportunity to develop more cost-effective remedial approaches.

Reliance on CVP Dilution Water

The current interim remedy relies upon water management options because the SCR is used to contain IMM AMD releases until they can be safely discharged, taking into account the dilution available in the Sacramento River flows and the limitations imposed by intense hydrologic conditions as well as the intense pollution loading from IMM. Additional source control programs at IMM will reduce, but may not eliminate, the heavy metal discharges. Special releases of Sacramento River waters may be required in the future to ensure adequate dilution of the IMM discharges. The manner in which dilution water may be acquired and provided to ensure protection of the Sacramento River fishery and aquatic ecosystem is described in EPA's June 1994 Water Management FS. Potential IMM remedial strategies that rely on special releases of dilution water as part of a final IMM remedy were taken into consideration in evaluating the appropriateness of the water management actions considered. The purchase of dilution water was retained for further consideration as a component of future remedial actions. Purchase of dilution water may provide an effective and cost-effective approach to providing a fully protective remedy for human health and the environment below Keswick Reservoir.

VII.2.6 Summary of Screening Analysis

Through this screening process, EPA determined that the following technologies and options are potentially suitable for assembly into alternatives for the Slickrock Creek area source AMD discharges:

- No further action
- Collection of surface water for treatment
- Physical-chemical treatment using the lime/HDS neutralization/precipitation process as a primary treatment process
- Physical-chemical treatment using the mechanical evaporation/crystallization process as a secondary treatment process following the lime/HDS process
- Landfill disposal of treatment sludge in a non-RCRA landfill
- Discharge of treated water to surface waters using an outfall
- Surface water diversions of less contaminated water using pipelines, open channels, dams, drop inlets, or ditches
- Containment basins in Slickrock Creek to temporarily store contaminated waters until water can be safely released or treated

VII.3 Alternatives

In June 1994, EPA published a Water Management FS, which examined potential remedial alternatives that could control, treat, or manage the safe release of continued uncontrolled contaminant discharges from the numerous and widely dispersed area sources in the Boulder Creek and Slickrock Creek watersheds at IMM. In the Water Management FS, EPA developed five alternatives for detailed evaluation that included a range of approaches relying on source control, collection and treatment, and water management technologies. Although some area sources could be readily identified and remediated (such as waste piles), a large proportion of the area source discharge was, in general, difficult to identify and characterize. As a result, the remedial alternatives that were developed and evaluated in the Water Management FS relied more heavily on collection and treatment approaches and water management approaches rather than on source control approaches. The five original detailed remedial alternatives for a sitewide remedy for the IMM area source AMD discharges were labeled WM0, WM1, WM2, WM3, and WM4. The EPA relied on the Water Management FS to develop its 1994 Proposed Plan, which identified a variation of Alternative WM3 as the preferred alternative. The EPA published this Proposed Plan in June 1994 and requested public comment on the proposed plan and related documents.

As a result of comments from the public and further study by EPA, EPA prepared the 1996 Water Management FSA, which presented a revised analysis of the No-Action Alternative, WM0, and developed and evaluated a new remedial alternative, SR1, which focused on a Slickrock Creek source control and treatment remedy.

Each of the alternatives is summarized below.

Alternative WM0

The No Further Action Alternative was evaluated as required by the NCP at 40 CFR § 300.430(e)(6) to determine the risks that would be posed to human health and the environment if no further actions were taken at IMM to address the continuing AMD discharges. The No Further Action Alternative is relied on as a baseline alternative against which other alternatives are judged. The No Further Action Alternative would include provisions for continued limited monitoring, operation and maintenance of the IMM treatment plant facilities, operation and maintenance of the ancillary facilities and other projects constructed pursuant to ROD1, ROD2, and ROD3 for the IMM Site, and continued operation of SCDD in accordance with the existing 1980 Memorandum of Understanding.

The EPA has determined that this alternative would not meet remedial action objectives.

Alternative WM1

Alternative WM1 relies on the increased water management capability provided by the enlargement of the SCR to 15,000 acre-feet. This approach would involve the construction of a 75-foot raise to the SCDD. The USBR would coordinate operations of the SCR with its CVP operations. Dilution water would not be purchased during the expected infrequent spill events.

The EPA's analysis concluded that the increased storage capacity for the contaminated IMM discharges and Spring Creek watershed runoff would reduce SCDD contaminant spills to one to three per century and provide significantly increased protection to the Sacramento River. The cost of this alternative is estimated to be $75.2 million.

Alternative WM2

Alternative WM2 relies on the increased water management capability provided by the enlargement of the SCR to 15,000 acre-feet. Additionally, under this alternative, the contaminated base flow of Slickrock Creek would be collected and treated at the existing IMM treatment plant. In addition to the 75-foot raise to SCDD, this approach involves the construction of a small dam in Slickrock Creek, a pipeline, and only limited modifications to the IMM treatment plant.

The EPA's analysis concluded that the increased storage capacity, coupled with treatment of the contaminated Slickrock Creek base flows, would reduce SCDD contaminant spills to once per century, reduce the currently uncontrolled site discharges by 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) by treating up to 50 percent of the Slickrock Creek area source AMD, and provide significantly increased protection to the Sacramento River. The cost of this alternative is estimated to be $79.4 million.

Alternative WM3

Alternative WM3 relies on the increased water management capability provided by the enlargement of the SCR to 15,000 acre-feet, the collection and treatment of the contaminated base flow of Slickrock Creek, and the purchase of dilution water during rare SCDD spill events. In addition to the 75-foot raise to SCDD, this approach involves the construction of a small dam in Slickrock Creek, a pipeline, and only limited modifications to the IMM treatment plant.

The EPA's analysis concluded that this alternative would provide similar metals reductions to Alternative WM2. The ability to purchase limited amounts of dilution water during spills would allow for the mitigation of the expected rare SCDD spill event and provide for increased protectiveness over Alternative WM2. The cost of this alternative is estimated to be $89.1 million.

Alternative WM4

Alternative WM4 relies on the collection and treatment of all contaminated flows in Boulder Creek and Slickrock Creek up to a 100-year storm event. This approach involves the construction of two small dams, clean water diversions, pipelines, and an expanded treatment plant. The alternative could potentially restore some of the beneficial uses upstream of the SCDD.

The EPA's analysis concluded that this alternative would provide the most protection to the Sacramento River and the resources upstream of the SCDD as well as the greatest reduction in the Site metals discharges. The cost of this alternative is estimated to be $129.5 million.

Alternative SR1

Alternative SR1 incorporates a retention dam within the Slickrock Creek drainage, a clean-water diversion system, and upgrades to the pipeline and treatment plant. Alternative SR1 relies on the collection and treatment of the AMD-contaminated surface-water discharges that are from the area sources in the Slickrock Creek watershed at IMM. The remedy, as finally designed and implemented, may rely to some extent on source control of specific sources and on water management technologies (such as diverting nearby downstream sources into the containment pond area) to ensure collection of the contaminated surface flows as well as to minimize the amount of water that could become contaminated by the area source discharges and require treatment.

The Slickrock Creek retention dam and pond would be located within the Slickrock Creek drainage of Iron Mountain directly below the most heavily disturbed mining area in the watershed. Inflows include surface-water runoff from the highly disturbed mining areas, flows from the former open pit mine and current sludge disposal Site, flows from Slickrock Creek, and flows from the Old/No. 8 Mine Seep, and flows from the hematite pile area. The dam would be located approximately 200 feet upstream of the hematite pile (with the exact location to be determined during design). A conceptual depiction of the remedy is shown in Photo Exhibit 2. A dam at this location would collect drainage from an area of approximately 546 acres; however, 387 acres of the drainage area would be intercepted by a clean-water diversion (modified as necessary) and discharged into Slickrock Creek below the proposed retention dam. An additional 44 acres of drainage above Brick Flat Pit is also currently collected and diverted into Slickrock Creek below the proposed dam. The potential AMD-generating area of the Slickrock Creek drainage is therefore approximately 115 acres. The pond developed behind the dam will temporarily store AMD before it is conveyed by pipeline to the HDS treatment plant onsite. The retention dam will be sized to contain 100-year storms, which would require a reservoir capacity of at least 170 acre-feet. The exact size and capacity of the reservoir would be determined during the design phase, but preliminary information indicates that the retention dam would be approximately 105 feet high (75 feet above the existing streambed). This alternative also includes a retaining structure to prevent erosion of the hematite pile, consistent with California mining waste requirements. The cost of this alternative is estimated to be $ 21.2 million.

A bullet summary of the components of Alternative SR1 is presented below:

- Construct a retention dam and necessary surface water diversion facilities to ensure the collection and storage of contaminated surface runoff, interflow, and groundwater in the Slickrock Creek watershed at IMM.

- Construct facilities to provide controlled release of contaminated waters from the retention dam to the AMD conveyance pipeline to the IMM HDS/ASM lime neutralization treatment plant.

- Construct facilities to divert relatively uncontaminated surface water from the area upstream from the highly disturbed mining area of the Slickrock Creek basin and divert that water around the Slickrock Creek retention reservoir. The diversion shall also divert around the retention reservoir the water from the unmined side of the Slickrock Creek watershed.

- Take appropriate steps (including consideration of emergency failure scenarios) to integrate into the operation of the reservoir the collection and conveyance of the Old/No. 8 Mine Seep AMD to the IMM HDS/ASM lime neutralization treatment plant.

- Construct a hematite erosion control structure consistent with California mining waste requirements.

- Construct one or more sedimentation basin(s) or other EPA approved control structures in the Slickrock Creek watershed to minimize sedimentation of the Slickrock Creek retention reservoir and to ensure proper functioning of the controlled release facilities.

- Upgrade the hydraulic capacity of the existing pipeline (or if necessary construct a new pipeline) from Slickrock Creek to the Boulder Creek crossing as required to ensure adequate reliable capacity to convey Slickrock Creek and Old/No. 8 Mine Seep AMD.

- Construct an additional pipeline to reliably convey Slickrock Creek and Old/No. 8 Mine Seep AMD from the Boulder Creek Crossing to the IMM HDS/ASM lime neutralization treatment plant.

- Modify the IMM HDS/ASM lime neutralization treatment plant to ensure proper treatment, using the HDS/ASM treatment process, of the Slickrock Creek area source AMD discharges in conjunction with AMD flows collected pursuant to other Records of Decision.

- Construct a tunnel to provide for gravity discharge of the high volumes of effluent from the IMM HDS/ASM treatment plant to Spring Creek below the Upper Spring Creek diversion to Flat Creek.

- Construct facilities to assure collection of significant identified sources (including but not limited to seeps from Brick Flat Pit and the hematite piles) and convey those releases to the Slickrock Creek Retention Reservoir.

- Perform long-term operations and maintenance (O&M) of all components.

The alternatives are presented in tabular form below in Table 1.

TABLE 1
Summary of Descriptions
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Components
Alternative WM0–No Further Action.	Maintain partial cap, Slickrock Creek diversion, and Upper Spring Creek diversion.
	Continue treatment of AMD discharge from Richmond and Lawson portals and Old/No. 8 Mine Seep.
	Assumes that USBR will continue to operate the SCR in accordance with the 1980 MOU criteria.
	Continue water monitoring.

TABLE 1
Summary of Descriptions
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Components
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	Contains same elements as Alternative WM0 with the exception of the SCR operations criteria. Enlarge SCR to a capacity of 15,000 acre-feet. Operate the SCR in compliance with the SBPS. Provide special dilution releases for uncontrolled SCDD spills, only to the extent they can be made available.
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	Contains same elements as Alternative WM1, including the enlargement of the SCR to a capacity of 15,000 acre-feet. Collect and treat 750-gpm base flow from Slickrock Creek in HDS treatment facility. Operate the SCR in compliance with the SBPS. Provide special dilution releases for uncontrolled SCDD spills, only to the extent they can be made available.
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	Contains same elements as Alternative WM2, including the enlargement of the SCR to a capacity of 15,000 acre-feet, and the collection and treatment of 750-gpm base flow from Slickrock Creek in HDS treatment facility. Operate the SCR in compliance with the SBPS. Provide special dilution releases for uncontrolled SCDD spills with a limited amount of purchased dilution water.
Alternative WM4–Rely on the existing SCDD for backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	Contains same elements as Alternative WM0 with the exception of the SCR operations criteria. Build two alternative dams on Slickrock Creek and Boulder Creek. Build clean-water diversions. Collect and treat all contaminated runoff. Existing SCDD would be relied upon only as a backup in case of a failure of the treatment system.
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	Contains same elements as Alternative WM0 with the exception of the SCR operations criteria. Build clean-water diversions and a retention dam in Slickrock Creek. Upgrade the capacity in conveyance pipelines and the IMM HDS treatment plant. Build a tunnel to discharge treated AMD into Spring Creek. Build a control structure to prevent hematite erosion into Slickrock Creek. Provide controlled release of Slickrock Creek AMD from retention dam and treat at HDS plant. Operate the SCR in compliance with the SBPS.

TABLE 1
Summary of Descriptions
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Components
	Provide special dilution releases for uncontrolled SCDD spills, only to the extent they can be made available. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternative Study).

VIII. ALTERNATIVE COMPARISONS

The detailed analysis of alternatives consists of an assessment of individual alternatives against nine evaluation criteria identified in the NCP and a comparative analysis that focuses on the relative performance of each alternative against those criteria. The resulting strengths and weaknesses of the alternatives are weighed to identify the alternative providing the best balance among the nine criteria. The nine evaluation criteria specified by the NCP in 40 CFR § 300.430(e)(9) are: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) reduction of toxicity, mobility, or volume through treatment; (4) long-term effectiveness and permanence; (5) short-term effectiveness; (6) implementability; (7) cost; (8) State acceptance; and (9) community acceptance. Assessment of two of the nine criteria, State acceptance and community acceptance, is not completed until after comments on the Proposed Plan are received.

Other than Alternative SR1 which addresses only remediation of area sources in the most heavily impacted reach of Slickrock Creek and the No-Action Alternative, each alternative addresses the remediation of AMD discharges from the entire IMM Site by addressing capture of both Slickrock and Boulder Creeks. Alternative SR1 does not address Boulder Creek area sources because further studies are underway to define the best way to remediate those sources. As set forth in EPA's August 1995 Boulder Creek Remedial Alternatives Study, EPA has determined that a range of alternatives is available for the Boulder Creek area source AMD discharges so that Alternative SR1, in combination with an appropriate Boulder Creek area source remedy, provides protection equivalent to Alternative WM4 and superior to Alternatives WM0, WM1, WM2, and WM3.

The consideration of an alternative that addresses Slickrock Creek without requiring completion of the studies for Boulder Creek is consistent with 40 CFR § 300.430(a)(ii)(A), which identifies as a program management principle that "[s]ites should generally be remediated in operable units when necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size and complexity of the Site, or to expedite the completion of total Site cleanup."

VIII.1 Criterion 1—Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Protection of Human Health

Concentrated acidic waters with high levels of heavy metals are harmful to humans. The concentrated IMM AMD is mainly limited to remote and uninhabited areas, such as Spring Creek and its tributaries. Controls are currently in place to restrict access to those areas, but human consumption of these flows is not impossible. Alternatives WM4 and SR1 provide the potential for some improvement (compared to the other alternatives) in protection of human health because in varying degrees these alternatives could reduce metal concentrations in lower Spring Creek and its tributaries. Overall, however, this improvement is considered marginal in light of the limited access to those water bodies.

The relative protection of human health associated with dilute AMD releases below the SCDD is not a major issue for evaluating either the No-Action Alternative or the action alternatives. Although the IMM AMD from the Slickrock Creek area sources discharges into the Sacramento River, which is a source of drinking water, the nearest point of withdrawal from the Sacramento River for domestic or municipal water use is downstream from Keswick Dam. Even under the No-Action Alternative, EPA anticipates that the Safe Drinking Water Standards will be met at that point. Further, the RWQCB coordinates with the City of Redding during SCDD spill and emergency release periods so that groundwater can be used if appropriate, thereby providing additional protection to human health. The remedies that reduce metal loads to state waters would be expected to reduce human health risks associated with consumption of fish contaminated with high levels of heavy metals from IMM, although the risks associated with such consumption has not been quantified.

Remedy SR1 would reduce exposure to arsenic associated with the hematite pile, so the remedy would protect human health with respect to future releases from the hematite piles. Exposures resulting from past releases from the hematite pile are not addressed by this remedy.

Protection of the Environment

The level of environmental protection of the alternatives varies. The No-Action Alternative, WM0, provides only a continuation of the controls now in place (the partial cap, the Spring Creek and Slickrock Creek diversions, and treatment of the AMD discharges from the Richmond/Lawson portals and Old Mine/No. 8 Mine Seep). The No-Action Alternative is not considered to be protective. Present impacts to the environment would remain unchanged or would become more severe over time. The current water quality degradation and associated impacts would continue in Slickrock Creek, Boulder Creek, Spring Creek, SCR, Keswick Reservoir, and the Sacramento River. IMM AMD would continue to constitute the dominant source of heavy metal loading to the upper Sacramento River during storms. Uncontrolled SCDD spills are expected to occur on average every 3 to 4 years if the SCDD is operated to achieve the SBPS below Keswick Dam. Operating the SCDD to meet the recently proposed PCTR (below Keswick Dam) would cause the spills to occur ever 2 to 3 years on average. Spills would occur even more frequently if the SCR were operated to target compliance with these standards in Keswick Reservoir rather than downstream of Keswick Dam. If dilution water releases can be made available from Shasta Dam, then the uncontrolled SCDD spill would be diluted, thereby minimizing its impact on the environment. This alternative, however, does not involve any action to ensure such flows will be available, so reliance upon such flows would be speculative. IMM would continue to discharge large volumes of heavy metal precipitates into the waters of the State. Some of these precipitates would become toxic sediments, adversely affecting benthic organisms and water column species and their habitat. High metal loads would continue to cause sub-lethal effects on aquatic resources.

The alternatives which increase SCDD capacity (Alternatives WM1, WM2, and WM3) reduce the frequency of an uncontrolled spill from the SCDD, which would decrease the frequency of the exceedances of the SBPS and PCTR below the SCDD. Alternative WM1 would reduce SCDD spill frequency to approximately one to three spills per century. Alternatives WM2 and WM3, which combine dam enlargement with treatment of the base flow from Slickrock Creek, are estimated to reduce the amount of metals released into the environment by about 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) on average compared to Alternatives WM0 or WM1. Alternatives WM2 and WM3 would reduce spills to a frequency of one per century or less. Alternative WM3 attempts to minimize the impact of the rare uncontrolled spills by arranging for purchase of some of the required dilution water. The other two alternatives rely on current operations of Shasta Dam to the extent special releases of dilution water could be made available and if downstream conditions would allow for the releases. None of these alternatives would attain safe and protective metal levels in the SCAKR. The severe impacts above the SCDD remain unabated.

Alternative WM4 is expected to provide the most protection of the environment because the remedy provides the greatest reduction in metals discharges. The remedy would be designed to treat all contaminated flows up to a 100-year, 3-day storm, so Alternative WM4 would reduce SCR contaminant spills to less than once per century. This remedy could generally achieve safe and protective metal levels in the SCAKR. The alternative is also expected to improve the water quality in the receiving waters in the Spring Creek watershed (including Spring Creek, and possibly Boulder and Slickrock Creeks) because the remedy would remove the large metal loads that would otherwise be discharged to those creeks. While EPA would not anticipate that all beneficial uses would be restored, the conditions could potentially improve to a point that many uses are partially restored. Additional response actions might also be available to further enhance those water bodies, such as removal of the contaminated stream sediments.

Alternative SR1 involves treatment of the Slickrock Creek area sources discharging to the most heavily impacted area of Slickrock Creek. The treatment of those sources is expected to on average reduce the release of copper by 60 to 70 percent and zinc and cadmium by 40 to 50 percent compared to Alternatives WM0 and WM1. The alternative is expected to reduce the frequency of SCDD spills to once every 8 to 10 years (when the SCDD is operated to target compliance with the SBPS below Keswick Dam). The duration and toxicity of spills would be reduced from the spills that would occur under Alternatives WM1, WM2, and WM3. Alternative SR1 would also improve the water quality in the SCAKR and therefore reduce the risk to species in that watershed. The alternative is also expected to improve the water quality in the receiving waters in Spring Creek and Slickrock Creek because the remedy would remove the large metal loads that would otherwise be discharged to those creeks. While EPA would not anticipate that all beneficial uses would be restored to those creeks, the conditions could potentially improve to a point that some uses are partially restored. This remedy could potentially be more protective than Alternative WM4 with respect to lower Slickrock Creek because Alternative SR1 involves diverting relatively less contaminated water to the lower reach of Slickrock Creek, which would provide dilution water and additional flow to that reach. The alternative is less protective than Alternative WM4 with respect to Spring Creek and Boulder Creek because Alternative SR1 does not address the metal being discharged to Boulder Creek. Alternative SR1 would also reduce the risks posed by the continuing release of arsenic from the hematite piles in the Slickrock Creek basin.

Alternative SR1, in combination with a subsequent remedy for the Boulder Creek area sources, is expected to be able to reduce metal loads to practically the same degree as Alternative WM4, if necessary. Alternative SR1, in combination with a Boulder Creek area source remedy, is expected to be able to reduce SCDD spills to less than once per century, if necessary, and to reduce mass metal loading to State waters to practically the same degree as Alternative WM4. Alternative SR1, in combination with available alternatives for Boulder Creek, could approach or equal Alternative WM4 with respect to protecting Keswick Reservoir and the water bodies upstream of the SCDD. Additional response actions might also be available to further enhance those water bodies.

All of the remedies rely upon continuation of the existing treatment operations, and several of the remedies involve treatment of additional flows. Although operational upsets of the treatment plant are expected to be rare, occasional spills from the treatment plant related to operational problems are expected. The effect of treatment plant upsets is not expected to substantially impact the overall protectiveness of the remedial approaches that rely on treatment. The SCR would be relied on as a backup measure to store these contaminated plant spills until they could be safely released into the Sacramento River.

Overall, the No-Action Alternative provides inadequate environmental protection. The SCDD enlargement alternatives (WM1, WM2, and WM3) provide adequate to high levels of protection of the environment below Keswick Dam and some additional protection to the environment in Keswick Reservoir. Alternatives WM1, WM2 and WM3 do not appreciably improve conditions upstream of the SCDD; Alternative WM4 provides the greatest protection to the environment both above and below the SCDD. Alternative WM4 is also most effective in terms of reducing the mass loading of heavy metals to the waters of the State and provides the greatest potential for restoration of some beneficial uses above the Spring Creek Debris Dam. Alternative SR1 provides significant protection to resources below the SCDD and the potential for some additional protection for reaches of Spring Creek and Slickrock Creek. Alternative SR1 coupled with an available response action in Boulder

Creek could provide protection equivalent to Alternative WM4 and superior to Alternatives WM0, WM1, WM2, and WM3.

Table 2 presents a comparison of each alternative's ability to protect human health and the environment.

TABLE 2
Summary of Overall Protection of Human Health and the Environment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	Human health risk is expected to be low. If the SCDD is operated to achieve the SBPS below Keswick Dam, uncontrolled SCDD spills are expected to occur on average every 3 to 4 years. Operating the SCDD to target the PCTR below Keswick Dam would cause the spills to occur ever 2 to 3 years on average. Spills would occur even more frequently if the SCR were operated to target compliance with these standards in Keswick Reservoir rather than downstream of Keswick Dam. Repeated uncontrolled SCDD spills may increase severity of environmental impacts. Spring Creek arm of Keswick Reservoir continues to have regular exceedances of the SBPS and PCTR. IMM AMD would continue to discharge very large loads of heavy metals to State waters and expose aquatic resources to sub-lethal levels of dissolved and particulate heavy metals. No environmental improvement above SCDD.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	Human health risk is expected to be low. Significant environmental impact reduction by reducing SCDD spill frequency to two to three times in 100 years if SCDD targets compliance with the SBPS below Keswick Dam; AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. Spring Creek arm of Keswick Reservoir continues to have regular exceedances of the SBPS and PCTR. Release of mass metal loads from IMM to State waters continues unabated; risk to benthic, water column, and other species because of continuous exposure to large loads of dissolved and particulate heavy metals. No environmental improvement above SCDD.

TABLE 2
Summary of Overall Protection of Human Health and the Environment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	Human health risk is expected to be low. Provides significant environmental impact reduction by reducing SCDD spill frequency to once in 100 years or better (assuming SCDD targets compliance with the SBPS below Keswick Dam) and by reducing toxicity of spills relative to Alternative WM1 (because of baseflow treatment); exceedances of the PCTR would be more frequent than exceedances of the SBPS. Targeting SCDD operations to attain PCTR would be expected to cause more frequent spills and SBPS exceedances. The treatment of Slickrock Creek base flows will reduce metals loads by 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) and significantly reduce metals concentrations in SCR, Keswick Reservoir, and the Sacramento River. Spring Creek arm of Keswick Reservoir continues to have regular exceedances of the SBPS and PCTR. Mass metal loads from IMM AMD reduced by 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) on average, but loading to State waters still very large; releases continue to pose risk to benthic, water column, and other species because of continuous exposure to large loads of dissolved and particulate heavy metals. Potential for minor environmental improvement above SCDD.
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	Human health risk is expected to be low. Provides significant environmental impact reduction by reducing SCDD spill frequency to once in 100 years or better (assuming SCDD targets compliance with the SBPS below Keswick Dam) and by reducing toxicity of spills relative to Alternative WM1 (because of baseflow treatment) and WM2 (due to purchased dilution water); exceedances of the PCTR would be more frequent than exceedances of the SBPS. Targeting SCDD operations to attain PCTR would be expected to cause more frequent spills and SBPS exceedances. The treatment of Slickrock Creek base flows will reduce metals loads by 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) and significantly reduce metals concentrations in SCR, Keswick Reservoir, and the Sacramento River. Because dilution water is available, severity of uncontrolled SCDD spills can be reduced. Spring Creek arm of Keswick Reservoir continues to have regular exceedances of the SBPS and PCTR. Mass metal loads from IMM AMD reduced by 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) on average, but loading to State waters still very large; releases continue to pose risk

TABLE 2
Summary of Overall Protection of Human Health and the Environment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	to benthic, water column, and other species because of continuous exposure to large loads of dissolved and particulate heavy metals. Potential for minor environmental improvement above SCDD.
Alternative WM4–Rely on the existing SCDD for backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	Human health risk is expected to be low. The treatment of all AMD will essentially eliminate the IMM metals discharge and greatly reduce metals concentrations in SCR, Keswick Reservoir, and the Sacramento River. The SCR can be relied upon to prevent spills to the Sacramento River. SBPS and PCTR expected to be met in Spring Creek arm of Keswick Reservoir except during most extreme and unusual events. Increased potential for environmental improvement above SCDD relative to other alternatives.
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	Human health risk is expected to be low. The treatment of Slickrock Creek AMD will reduce under all conditions the metals load by 60 to 70 percent (copper) and 40 to 50 percent (zinc and cadmium), and significantly reduce the metals concentrations in SCR, Keswick Reservoir, and the Sacramento River below Keswick Dam. SCDD spills will be less toxic and reduced to once every 8 to 10 years if SCDD operated to target compliance with the SBPS below Keswick Dam; SCDD spills expected every 4 to 8 years if the SCDD is operated to target compliance with the PCTR below Keswick Dam. Spring Creek arm of Keswick Reservoir continues to have regular exceedances of the SBPS and PCTR. Potential for some environmental improvement above SCDD. Mass metal loads from IMM AMD reduced by 60 to 70 percent (copper) and 40 to 50 percent (zinc and cadmium) under all flow conditions. Reduction in risk to benthic, water column, and other species due to decrease in exposure to large loads of dissolved and particulate heavy metals. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternative Study). Combining Alternative SR1 with a subsequent Boulder Creek area source remedy could reduce spills to once in 100 years and reduce spill toxicity and duration. Additional source controls could provide further reductions as necessary; combined remedy could potentially

TABLE 2
Summary of Overall Protection of Human Health and the Environment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	reduce mass loading from IMM AMD by significant amount and permit attainment of standards in the Spring Creek arm of Keswick Reservoir and restoration of at least some beneficial uses to Spring Creek watershed waters.

VIII.2 Criterion 2—Compliance with Applicable or Relevant and Appropriate Requirements and To Be Considered Standards

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental siting law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

Compliance with ARARs addresses whether a remedy will meet all Federal and State environmental laws and/or provide a basis for a waiver from any of these laws. These ARARs are divided into chemical-specific, action-specific, and location-specific groups.

In addition to legally binding laws and regulations, EPA is to consider proposed standards and other guidance that, while not legally binding, provide useful information regarding the performance of the remedy. These other standards are referred to as "To Be Considered" standards or TBCs. As discussed above, the EPA recently promulgated draft statewide numeric water quality criteria (the PCTR). If the criteria had been finalized by the time of ROD signature, the criteria would apply to this action. The EPA considers these criteria as TBC because the criteria provide useful information regarding risks posed by AMD releases. The PCTR are based on well established procedures for deriving water quality criteria, and the criteria take into account a wide array of aquatic toxicity issues. Consideration of the criteria will enable EPA to predict ARARs that are likely to apply to future response actions. The EPA has therefore evaluated the extent to which the proposed remedy would comply with these proposed standards. In general, targeting SCDD operations to attain compliance with the PCTR increases the frequency of exceedances of the SBPS because water must be released from the SCR more slowly. Targeting SCDD operations to attain compliance with the SBPS results in frequent exceedances of the PCTR chronic water quality criteria for copper because the SBPS are less stringent than the PCTR with respect to copper.

ARAR Compliance Upstream of Spring Creek Debris Dam

None of the alternatives fully complies with ARARs because none of the alternatives would achieve SBPS or the PCTR in Spring Creek, Slickrock Creek, or Boulder Creek. Depending upon subsequent remedial decisionmaking, EPA may ultimately need to waive at least some of the ARARs for these heavily impacted water bodies on the basis of technical impracticability. The EPA requested comment on a proposed ARAR waiver for these streams during public comment period.

None of the streams above the SCDD currently support aquatic life, and no option has yet been developed which would effectively restore all these streams to life. The remedial actions implemented to date, and those considered in the 1994 FS and 1996 FSA, may allow for the restoration of some beneficial uses to these surface waters. It is expected that any ARAR waiver would be limited to those response actions which would be technically impracticable, and would not extend to clearly feasible measures, such as compliance with Best Management Practices, SBPS, other ARARs for current control measures at IMM, or feasible actions to provide incremental improvements of the toxicity criteria which may improve conditions for more tolerant life forms, such as plants and invertebrates, even if more stringent toxicity criteria cannot be met.

ARAR Compliance in Keswick Reservoir

Alternative WM4 would achieve compliance with ARARs in Keswick Reservoir in most circumstances, but occasional exceedances in Keswick Reservoir may occur as a result of the difficult operations that are required to manage the safe dilution of the peak discharges of stormwater runoff. Alternative SR1, in combination with certain potential remedial actions for the Boulder Creek area source AMD discharges, could also allow for compliance with ARARs in Keswick Reservoir in most circumstances. Alternatives WM2 and WM3 are expected to result in some improvement in water quality in Keswick Reservoir over Alternatives WM0 and WM1 because of the increased treatment.

ARAR Compliance below Keswick Dam

Alternatives WM1 through WM3 would meet SBPS below Keswick Dam in all but the most unusual events, projected at one to three times per century, depending on the availability of dilution water in those years (with slightly a greater frequency of spills expected if the SCDD is targeting compliance with the PCTR below Keswick Dam). Alternatives WM2 and WM3 would more reliably meet the SBPS than Alternative WM1 because those alternatives remove a significant concentration of metals from the water impounded behind SCDD. Of the two, compliance with SBPS and PCTR may be somewhat more reliable in the extreme events under WM3 because Alternative WM3 would rely upon the exercise of water rights (to the extent they become available), while Alternative WM2 contains no such protection.

Alternative SR1 would meet the SBPS below Keswick Dam except during IMM AMD spills from SCDD, which are projected to occur on a frequency of once every 8 to 10 years (when the SCDD is operated to target compliance with the SBPS below Keswick Dam). The metal concentrations and thus the toxicity of the spills would be reduced because of the treatment of the Slickrock Creek area source discharges. Alternative SR1 would also significantly reduce the duration of the spill events, because treatment would cause the SCR water to be less toxic and therefore permit release at a faster rate. Operating the SCDD to target compliance with the PCTR below Keswick Dam is predicted to result in exceedances every 4 to 8 years.

Of the five alternatives, Alternative WM4 best complies with water quality standard ARARs and TBCs below the SCDD.

All treatment options (Alternatives WM2 through WM4 and SR1) rely upon established treatment technologies. To the extent that any treated sludge exceeds the standards for hazardous waste under applicable California law, the treatment option would require a variance from standards applicable to the disposal of mining waste. Current response actions (including the ongoing treatment plant operations and sludge disposal) rely upon a variance from such standards. Since each of the treatment alternatives relies upon the same treatment plant and technology, it is not anticipated that there will be any significant degree of difference among the treatment alternatives in their relative compliance with the State mining waste standards.

Insofar as all the action alternatives further the goals of the various natural resource protection ARARs identified for this Site, they all help in meeting ARARs. Of the treatment options, however, Alternative WM4 best achieves the goals of Fish and Game Code Section 5650, which prohibits the discharge of material deleterious to fish life, and Section 5651, which encourages the implementation of best available control technology on chronic pollution sources. Alternatives WM1 through WM3 and SR1 all further this goal to some degree, relative to the degree by which they reduce the metals loading from Site discharges and permit compliance with the SBPS and PCTR in receiving waters.

Alternatives WM1 through WM4 and SR1 also all help achieve the ends of the State Endangered Species Act and Federal Endangered Species Act because all will result in substantial improvements in water quality below Keswick Dam, which is the location of the endangered winter-run chinook salmon and other important species such as the steelhead trout and spring run salmon. Alternative WM4 best achieves this ARAR because it provides a more consistent level of protection. Alternatives WM1 through WM3 and SR1 also provide substantial protection because the chances of a spill event are reduced to one to seven per century. Alternative WM3 is the best option of the three alternatives that rely on an enlarged SCR in that it provides both treatment and a more reliable dilution option in those spill years in which dilution is feasible. Alternative SR1 provides greater reduction in the metals discharge than these three alternatives, but would allow for more frequent, although less toxic, spills. Alternative SR1, in combination with an appropriate subsequent remedy for the Boulder Creek area sources, could potentially provide protection from SCDD spills essentially equivalent to Alternatives WM1 through WM4 and additional reduction in the Site metals discharge loads both above and below the SCDD.

Alternatives WM1 through WM4 and SR1 would comply with the Fish and Wildlife Coordination Act, an ARAR for those actions. Significantly less mitigation for remedial actions SR1 and WM4 is expected because the areas in which containment ponds would be established are currently highly impacted by the past mining activity.

ARAR Exceedances Because of Sediments

With respect to all options, it is anticipated that occasional re-suspension of sediments now located in the SCAKR could result in exceedances of ARARs, notably Fish and Game Code Section 5650 and SBPS, both in Keswick Reservoir and below Keswick Dam. Because these sediments are not being addressed in this action, but will be addressed in a subsequent study, it would be appropriate to invoke an interim remedy ARARs waiver to the degree it is anticipated these sediments may result in ARARs exceedances.

Alternative SR1 would also achieve compliance with state mining laws with respect to control of the hematite piles.

Table 3 below presents a summary of each alternative's compliance with ARARs.

TABLE 3
Summary of Compliance with ARARs
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	If the SCDD is operated to achieve the SBPS below Keswick Dam, uncontrolled SCDD spills are expected to occur on average every 3 to 4 years. SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. Operating the SCDD to target the PCTR below Keswick Dam would cause the spills to occur every 2 to 3 years on average. Spills would occur even more frequently if the SCR were operated to target compliance with these standards in Keswick Reservoir rather than downstream of Keswick Dam. PCTR and SBPS would continue to be exceeded in Keswick Reservoir and the creeks that drain Iron Mountain. Does not further the goal of Fish & Game Code Sections 5650 and 5651. No archeological and/or historical sites would be disturbed. No flood plains or wetlands would be disturbed. Uncontrolled SCDD spills of toxic AMD discharges threaten the endangered winter-run chinook salmon.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	SCDD spill frequency reduced to two to three times in 100 years if SCDD targets compliance with the SBPS below Keswick Dam; SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. The SBPS are expected to be exceeded in the Sacramento River below Keswick Dam because of AMD spills one to three times per century. PCTR and SBPS would continue to be exceeded in Keswick Reservoir and the creeks that drain Iron Mountain. Exceedances of the PCTR would be more frequent than exceed-

TABLE 3
Summary of Compliance with ARARs
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	ances of the SBPS; targeting SCDD operations to attain PCTR would cause more frequent spills and SBPS exceedances. Furthers goal of Fish & Game Code Sections 5650 and 5651 only below SCDD. Exceedances because of sediments to continue. No archeological and/or historical sites will be disturbed. No harmful impacts to endangered species are anticipated. The EPA continues to coordinate with State and Federal Natural Resource Trustees, and consult with NMFS consistent with the provisions of the Endangered Species Act. Mitigation is required related to expected unavoidable impacts to chaparral and riparian habitat. In accordance with the Fish and Wildlife Coordination Act, EPA would consult with the USFWS during design of this alternative.
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	SCDD spills expected once in 100 years if SCDD targets compliance with the SBPS below Keswick Dam; SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. Exceedance of SBPS and PCTR reduced during spill periods due to baseflow treatment. PCTR and SBPS would continue to be exceeded in Keswick Reservoir and the creeks that drain Iron Mountain. Furthers goal of Fish & Game Code Sections 5650 and 5651 primarily below SCDD. Exceedances because of sediments to continue. No archeological and/or historical sites would be disturbed. No harmful impacts to endangered species are anticipated. The EPA continues to coordinate with State and Federal Natural Resource Trustees, consistent with the provisions of the Endangered Species Act. Mitigation is required related to expected unavoidable impacts to chaparral and riparian habitat. In accordance with the Fish and Wildlife Coordination Act, EPA would consult with the USFWS during design of this alternative.
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	SCDD spills expected once in 100 years if SCDD targets compliance with the SBPS below Keswick Dam; SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. Exceedance of SBPS and PCTR reduced during spill

TABLE 3
Summary of Compliance with ARARs
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	periods due to baseflow treatment and purchased dilution water. PCTR and SBPS would continue to be exceeded in Keswick Reservoir and the creeks that drain Iron Mountain. Furthers goal of Fish & Game Code Sections 5650 and 5651 primarily below SCDD. Exceedances because of sediments to continue. No archeological and/or historical sites would be disturbed. No harmful impacts to endangered species are anticipated. The EPA continues to coordinate with State and Federal Natural Resource Trustees and consult with NMFS consistent with the provisions of the Endangered Species Act. Mitigation is required related to expected unavoidable impacts to chaparral and riparian habitat. In accordance with the Fish and Wildlife Coordination Act, EPA would consult with the USFWS during design of this alternative.
Alternative WM4–Rely on the existing SCDD for backup for plant failures, build two alternative dams (one on Slickrock Creek and one on Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	SCDD spills expected once in 100 years if SCDD targets compliance with the SBPS below Keswick Dam; SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. SBPS and PCTR attained in Keswick Reservoir except in unusual circumstances. PCTR and SBPS expected to be exceeded in the creeks that drain Iron Mountain but to a lesser degree than the other alternatives. Furthers goal of Fish & Game Code Sections 5650 and 5651 both above and below the SCDD. Exceedances because of sediments to continue. No archeological and/or historical sites would be disturbed. No harmful impacts to endangered species are anticipated. The EPA continues to coordinate with State and Federal Natural Resource Trustees and consult with NMFS, consistent with the provisions of the Endangered Species Act. Mitigation may be required related to expected unavoidable impacts to chaparral and riparian habitat that is currently highly impacted by historic mining. In accordance with the Fish and Wildlife Coordination Act, EPA would consult with the USFWS during design of this alternative.

TABLE 3
Summary of Compliance with ARARs
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	SCDD spills expected every 8 to 10 years on average if SCDD targets compliance with the SBPS below Keswick Dam; SBPS attained below Keswick Dam during non-spill periods but PCTR exceeded below Keswick Dam even during non-spill periods. AMD spills expected to occur more frequently if SCDD targets compliance with the PCTR below Keswick Dam. SBPS and PCTR are also expected to be exceeded in Keswick Reservoir and the creeks that drain Iron Mountain. Furthers goal of Fish & Game Code Sections 5650 and 5651 below the SCDD and to some degree on Slickrock Creek and lower Spring Creek. Exceedances because of sediments to continue. No archeological and/or historical sites would be disturbed. Alternative SR1 does not fully eliminate all spills from SCDD, does not delay spills as the enlarged SCDD alternatives do, and would not prevent all harm to endangered species. Additional actions in Boulder Creek could further reduce the frequency, toxicity, and duration of spills, providing significant additional protection to endangered species. The EPA continues to coordinate with State and Federal Natural Resource Trustees and consult with NMFS, consistent with the provisions of the Endangered Species Act. Mitigation may be required related to expected unavoidable impacts to chaparral and riparian habitat that is currently highly impacted by historic mining. In accordance with the Fish and Wildlife Coordination Act, EPA would consult with the USFWS during design of this alternative.

VIII.3 Criterion 3—Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

Under the No Further Action Alternative, WM0, long-term effects would continue as under their present condition. The discharge of areawide sources of AMD would continue for thousands of years if left unabated. The affected portion of Spring Creek watershed will continue to be devoid of aquatic life, amphibians, and other affected resources. Sediments containing elevated levels of metals would continue to be deposited in the creeks, behind SCDD, and in SCAKR. Uncontrolled spills of IMM contaminants would continue to occur every 3 to 4 years if the SCR is operated to target the SBPS below Keswick Dam and every 2 to 3 years if the SCR is operated to target the PCTR below Keswick Dam.

Alternatives WM2 and WM3 would remove an estimated 30 to 35 percent (copper) and 20 to 25 percent (zinc and cadmium) of the remaining uncontrolled Site discharge by treating up to 50 percent of the Slickrock Creek area source AMD metals discharge load. The remedy would treat a larger percent when flows are low and a smaller percent when flows are high. Alternative SR1 would remove essentially all of the Slickrock Creek area source AMD discharge load. (In the EPA Water Quality Model, EPA generally relied upon an efficiency of 90 percent as a conservative estimate, but EPA anticipates that the remedy will be more effective than that estimate.) The Slickrock Creek area sources comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium site discharges. Alternative WM4 would remove essentially 100 percent of the remaining Site discharge load. Alternative SR1, in combination with a subsequent Boulder Creek area source remedy, could equal or approach the metal reduction provided by Alternative WM4. Alternatives WM1 and WM0 would not provide for any additional metals removal.

Enlarging the SCR to a capacity of 15,000 acre-feet, as proposed in Alternatives WM1, WM2, and WM3, is expected to provide significant, effective, long-term protection to human health and the environment below Keswick Dam. An enlarged dam would require periodic maintenance, but is expected to have a project design life in excess of 100 years. The enlarged SCR is a passive device that is expected to provide significant additional hydrologic controls. The additional hydrologic controls would provide for a significant reduction in toxic spill frequency and greater compliance with the protective SBPS and PCTR below the SCDD than is possible under current conditions. Enlarged SCR capacity would also provide additional protection with respect to treatment plant upsets because the enlarged reservoir would increase the ability to control the dilution of highly polluted water from the SCR.

Reducing the metal load to the SCR reduces the frequency of SCDD spills. If the water in the SCR contains lower concentrations of metals, the reservoir can release the water at faster rate because less dilution water would be needed. Alternatives WM2, WM3, WM4, and SR1 reduce metals discharges and therefore reduce spill frequency associated with operation of either the enlarged SCR (in the case of Alternatives WM2 and WM3) or the existing SCR (in the case of Alternatives WM4 or SR1). When coupled with the other response actions, this additional reduction in SCDD spills associated with the metals removal provides significant additional compliance with the protective SBPS and the PCTR below the SCDD and thus protection to the Sacramento River fishery and ecosystem. The metals reduction also decreases the overall metals discharge loading, the exposure of aquatic resources to heavy metals, and the resultant amount of metals deposition in the sediments behind SCDD and in the SCAKR. The continued deposition of sediments poses a threat to benthic and water column organisms as well as hindering the ability to effectively respond to the sediments caused by past IMM AMD releases. Removal of metals also increases the potential for the beneficial uses of Spring Creek and its tributaries to be restored.

All the alternatives would rely on the release of dilution water, if possible, to mitigate damage from the uncontrolled spills. Dilution water would be more likely to be available under Alternative WM3 because that alternative provides for the purchase of water rights for dilution water.

Alternative WM4 would provide the greatest long-term effectiveness by significantly reducing the metals discharged to the environment. The proposed treatment of all areawide sources by capturing the creek flows on Boulder and Slickrock Creeks and treating all contaminated flows would reduce the amount of metals by an estimated 99 percent. Contaminated creek sediments in the contaminated reaches of the Spring Creek watershed would continue to discharge metals for some period of time. The existing heavy metal-laden sediments in SCAKR could also act as a metal source as metals re-dissolve into the water. The operation of a treatment scheme that requires the collection and treatment of all storm flows is a difficult task, and cannot be expected to function perfectly. Some upset condition operations should be anticipated to reduce the overall effectiveness of this approach. Alternative SR1 could potentially be coupled with other response actions to achieve protection that is comparable to Alternative WM4.

Table 4 below presents a comparison of each alternative's ability to meet this criterion.

TABLE 4
Summary of Long-Term Effectiveness and Permanence
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	Not effective. Because no additional remedial action is implemented, environmental impacts will continue over the long term under their present condition. Metals releases and current risks may continue for thousands of years.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	Provides substantial long-term effectiveness for protection of human health and the environment. Infrequent fishery impacts below Keswick Dam are expected because of SCDD spills that would occur two to three times in 100 years. Aquatic resources below SCDD continue to be exposed to large loads of total and dissolved heavy metals. Receiving waters upstream of SCDD continue to be devoid of aquatic life; portion of Keswick Reservoir remains impaired. Heavy metal-laden sediments would continue to accumulate. Better control over SCDD releases during storm events is anticipated.
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	Provides significant long-term effectiveness for protection of human health and the environment. Rare fishery impacts below Keswick Dam are expected because of spills that would occur less than once in 100 years. Below SCDD, baseflow treatment permits reduction in metal loading (on average 30 to 35 percent [copper] and 20 to 25 percent [zinc and cadmium]), thereby reducing the exposure of aquatic resource to large loads of total and dissolved heavy metals. Heavy metal-laden sediments would continue to accumulate, but at a reduced rate.

TABLE 4
Summary of Long-Term Effectiveness and Permanence
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	Receiving waters upstream of SCDD continue to be devoid of aquatic life; Keswick Reservoir remains impaired. The collection system, pipelines, and treatment plant should operate effectively. Treatment of the AMD with the HDS plant is very reliable, and the plant would remove 99 percent of the metals discharged. Disposal of the treatment sludge in Brick Flat Pit would be effective over the long term. Better control over SCDD releases during storm events is anticipated.
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	Provides significant long-term effectiveness for protection of human health and the environment. Rare fishery impacts below Keswick Dam are expected because of SCDD spills that would occur once in 100 years. Mitigation with dilution water would reduce the impact of the rare spill. Below SCDD, baseflow treatment permits reduction in metal loading (on average 30 to 35 percent [copper] and 20 to 25 percent [zinc and cadmium]), thereby reducing the exposure of aquatic resource to large loads of total and dissolved heavy metals. Heavy metal-laden sediments would continue to accumulate, but at a reduced rate. Receiving waters upstream of SCDD continue to be devoid of aquatic life; Keswick Reservoir remains impaired. The collection system, pipelines, and treatment plant should operate effectively. Treatment of the AMD with the HDS plant is very reliable, and the plant would remove 99 percent of the metals discharged. Disposal of the treatment sludge in Brick Flat Pit would be effective over the long term. Better control over SCDD releases during storm events is anticipated.
Alternative WM4–Rely on the existing SCDD for backup for plant failures, build two alternative dams (one on Slickrock Creek and one on Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	Provides significant long-term effectiveness for protection of human health and the environment. SCDD spills would be expected to occur only under the rarest of circumstances. Essentially eliminates the IMM metals discharge. Heavy metal-laden sediments would not continue to accumulate. Significant reduction in exposure of aquatic resource to large loads of total and dissolved heavy metals. The dams, pipelines, and treatment plant should operate effectively. Treatment of the AMD with the HDS plant is very reliable, and the plant would remove 99 percent of the metals discharged. Disposal of the treatment sludge in Brick Flat Pit would be effective over the long term.

TABLE 4
Summary of Long-Term Effectiveness and Permanence
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative SR1–Construct a dam in Slickrock Creek and clean water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile	Provides significant long-term effectiveness for protection of human health and the environment. Occasional fishery impacts below Keswick Dam are expected because of spills that would occur once every 8 to 10 years. Provides significant reduction (60 to 70 percent copper and 40 to 50 percent zinc and cadmium) in metals load discharge under all conditions. Heavy metal-laden sediments would continue to accumulate, but at a much reduced rate. Potential for restoration of some beneficial uses of waters in Spring Creek Watershed. The collection system, pipelines, and treatment plant should operate effectively. Treatment of the AMD with the HDS plant is very reliable, and the plant would remove 99 percent of the metals discharged. Disposal of the treatment sludge in Brick Flat Pit would be effective over the long term. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternative Study). Alternative SR1, combined with an appropriate Boulder Creek source control and treatment remedy, is expected to be able to achieve further significant metal load reductions. The further load reductions in Boulder Creek could reduce spill frequency to less than once per century, which is comparable to Alternatives WM2, WM3, and WM4 and increases the potential for restoration of the beneficial uses of Spring Creek and its tributaries.

VIII.4 Criterion 4—Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the Site.

The No Further Action Alternative, WM0, is not expected to provide a reduction in toxicity, mobility, or volume because no further reductions in the IMM metal discharges would occur, and SCDD would continue to spill at its current frequency. Therefore, metals would continue to accumulate in the environment.

The SCDD enlargement alternatives will reduce the toxicity of the AMD discharge at the point below Keswick Dam to the SBPS through dilution, except during the one to three spills in 100 years. Exceedances of the PCTR below Keswick Dam would also be reduced. Alternative WM1 does not contain any treatment components; therefore, there will be no reduction in mobility or volume of AMD discharge. Alternatives WM2 and WM3 would treat up to approximately 750 gpm of Slickrock Creek base flow, thereby reducing the volume of AMD discharge by about 240 gpm on average. On an annual average, baseflow treatment is expected to reduce the uncontrolled release of copper by 30 to 35 percent and the uncontrolled release of zinc and cadmium by 20 to 25 percent. The mobility of the untreated AMD discharge would remain unchanged. Ensuring the availability of dilution water in Alternative WM3 increases the probability that the toxicity of an uncontrolled SCDD spill can be reduced. Alternative WM4 treats all the areawide sources of AMD discharge collected in dams constructed on Slickrock and Boulder Creeks. Alternative WM4 would provide the greatest decrease in the toxicity and volume of these discharges and would reduce the mobility of the metal contaminants by separating and binding the metals in a sludge, which will be disposed of in a landfill to limit future re-mobilization.

Alternative SR1 provides greater reductions in the volumes of IMM area source contaminants discharged than Alternatives WM2 and WM3, and less than under Alternative WM4. Alternative SR1 would collect and treat (under all conditions) essentially all Slickrock Creek area source discharges, which comprise approximately 60 to 70 percent (copper) and 40 to 50 percent (zinc and cadmium) of the currently uncontrolled IMM AMD discharge. Alternative SR1 provides for a significant reduction in toxicity of the SCR waters. Because Alternative SR1 does not include the increased hydrologic controls of Alternatives WM2 and WM3, Alternative SR1 does not ensure the same degree of reduction in the toxicity in the Sacramento River. Alternative SR1 is estimated to reduce spills from the SCR to once every 8 to 10 years (when the SCDD is operated to target compliance with the SBPS below Keswick Dam). When combined with a remedy for the Boulder Creek area sources (to be the subject of additional study and a later EPA decision), the Alternative SR1 could potentially be comparable to the other alternatives with respect to reduction in toxicity in the Sacramento River and an equivalent or greater reduction in volume and mobility both above and below the SCDD.

Table 5 below presents a comparison of each alternative's ability to meet this criterion.

TABLE 5
Summary of Reduction of Toxicity, Mobility, or Volume through Treatment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	No reduction in toxicity, mobility, or volume.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	Reduces the toxicity to SBPS below Keswick Dam of SCDD discharge except for one spill event per century (if SCDD operated to target compliance with SBPS below Keswick Dam). Also reduces exceedance of PCTR below Keswick Dam. No reduction in volume or mobility.
Alternative WM2–Enlarge SCR to 15,000 acre-feet,	Reduces the toxicity to SBPS below Keswick Dam of SCDD discharge except for one spill event per century (if SCDD operated to

TABLE 5
Summary of Reduction of Toxicity, Mobility, or Volume through Treatment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	target compliance with SBPS below Keswick Dam). The uncontrolled SCDD spill should be less toxic than WM1. Also reduces exceedance of PCTR below Keswick Dam.
	Provides some reduction in volume and mobility of AMD by treating 750-gpm base flow of Slickrock Creek. Also reduces exceedance of PCTR below Keswick Dam.
	Provides some reduction in volume of heavy metal precipitates, but large volumes of precipitates continue to settle into reservoirs and river beds
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	Reduces the toxicity to SBPS below Keswick Dam of SCDD discharge except for one spill event per century (if SCDD operated to target compliance with SBPS below Keswick Dam). The uncontrolled SCDD spill should be less toxic than WM1.
	Provides some reduction in volume and mobility of AMD by treating 750-gpm base flow of Slickrock Creek.
	Guaranteed dilution water increases probability of reducing toxicity of uncontrolled SCDD spill.
	Provides some reduction in volume of heavy metal precipitates, but large volumes of precipitates continue to settle into reservoirs and river beds.
Alternative WM4–Rely on the existing SCDD as backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	Reduces the toxicity to SBPS below Keswick Dam of SCDD discharge except for one spill event per century (if SCDD operated to target compliance with SBPS below Keswick Dam). The uncontrolled SCDD spill should be less toxic than Alternatives WM2 and WM3 because of increased removal of metals through treatment. Also reduces exceedance of PCTR below Keswick Dam.
	Greatly reduces toxicity, mobility, and volume of AMD by collecting and treating all IMM area sources of AMD.
	Greatly reduces volume of heavy metal precipitates and new sedimentation, thereby increasing potential for effective remediation of existing sediments.
	Treatment will improve the water quality in the Spring Creek watershed.
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	Reduces the toxicity to SBPS below Keswick Dam of SCDD discharge except for one spill event every 8 to 10 years (if SCDD operated to target compliance with SBPS below Keswick Dam). The uncontrolled SCDD spills should be less toxic than Alternatives WM2 and WM3 because of increased removal of metals through treatment. Also reduces exceedance of PCTR below Keswick Dam.
	Significantly reduces the toxicity, mobility, and volume of AMD

TABLE 5
Summary of Reduction of Toxicity, Mobility, or Volume through Treatment
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
	discharges by collecting and treating essentially all Slickrock Creek area sources of AMD under all conditions. Some reduction (greater reduction than Alternatives WM1 and WM2) in volume of heavy metal precipitates and new sedimentation. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternative Study). Alternative SR1, in combination with a Boulder Creek area source remedy, would be expected to provide equivalent reductions in the toxicity and frequency of spills provided under Alternatives WM2 and WM3 and greater reductions in volume and mobility of the contaminants. Combined remedy could potentially greatly reduce the volume of heavy metal precipitates and new sedimentation, thereby increasing the potential for effective remediation of existing sediments. Treatment will improve the water quality in the Spring Creek watershed.

VIII.5 Criterion 5—Short-Term Effectiveness

Short-term effectiveness refers to the period of time required to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

Some degree of increased traffic and related impacts are expected during construction, but none of the alternatives pose a substantial threat to the local communities. The alternatives with construction components expose workers to normal construction-related impacts and expose the environment to minor impacts which can be mitigated during construction. The alternatives with treatment components expose treatment plant operators to some risk from being exposed to AMD, but through proper operation, maintenance, and protection, the risk is minor.

The No Further Action Alternative does not propose any new construction that would adversely affect the environment. This alternative will not meet the remedial action objectives and does not mitigate the present environmental risks.

For the SCDD enlargement alternatives, Alternatives WM1 through WM3, there is no substantial threat to local communities because of the remote location of the IMM Site. Iron Mountain Road would be permanently relocated, which would minimize traffic conflicts associated with the project. During construction, however, there would be increased traffic on Iron Mountain Road. The project is large, but construction would be staged to reduce noise and dust impacts.

Environmental impacts of construction of an SCDD enlargement are expected to be minor, and it is anticipated that these impacts can be mitigated. The inundation of an additional 180 acres of land is an unavoidable minor impact. The EPA has consulted with USFWS regarding appropriate mitigation measures for an SCDD enlargement.

The two alternatives that treat the base flow from Slickrock Creek (Alternatives WM2 and WM3) will have only minimal additional short-term impacts because only minimal construction is required to modify the treatment plant and build conveyance pipelines to the existing treatment plant. Alternative WM4 requires a substantial amount of additional construction, including construction of two small dams, other water management projects, new pipelines, a significantly expanded treatment plant, and additional sludge handling facilities. During construction, Iron Mountain Road would experience greater traffic, as well as construction-related impacts such as dust and noise. Because the two new dams would be constructed upstream of the existing SCDD, a failure of one of these dams during construction would not present a threat to downstream residents.

Alternative SR1 requires substantial additional construction with a containment dam, the hematite containment structure, clean-water conveyances, new pipelines, and an expanded treatment plant. However, there would be less traffic and construction-related impacts such as dust and noise than in Alternatives WM1 through WM4. Because the new dam would be constructed upstream of the existing SCDD, a failure during construction would not present a threat to downstream residents. In the absence of rapid implementation of the remedy for Boulder Creek area sources, Alternative SR1 would be less effective in short-term reduction of metals, toxicity, and mobility than Alternative WM4. Investigation of Boulder Creek is continuing, so a remedy for those sources could potentially be implemented in the near-term.

The treatment alternatives share the common short-term advantage that the process can be readily modified to take advantage of improvements in treatment technology or changed economic conditions which may in the future favor resource recovery processes.

Table 6 below presents a comparison of each alternative's ability to meet this criterion.

TABLE 6
Summary of Short-Term Effectiveness
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	Does not meet remedial action objectives. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water,	No substantial threats to the local communities are anticipated. Increase in traffic and related impacts during construction. Workers exposed to normal construction-related risks.

TABLE 6
Summary of Short-Term Effectiveness
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
if dilution water is available.	Minor environmental impacts during construction, which can be mitigated. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers.
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	No substantial threats to the local communities are anticipated. Increase in traffic and related impacts during construction. Workers exposed to normal construction-related risks. Minor environmental impacts during construction, which can be mitigated. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers.
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	No substantial threats to the local communities are anticipated. Increase in traffic and related impacts during construction. Workers exposed to normal construction-related risks. Minor environmental impacts during construction, which can be mitigated. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers.
Alternative WM4–Rely on the existing SCDD as backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	No substantial threats to the local communities are anticipated. Increase in traffic and related impacts during construction. These impacts are greatest with this alternative because of the size of the project. Workers exposed to normal construction-related risks. Minor environmental impacts during construction, which can be mitigated. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers.

TABLE 6
Summary of Short-Term Effectiveness
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative SR1–Construct a dam in Slickrock Creek and clean water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	No substantial threats to local communities are anticipated. Increase in traffic and related impacts during construction. Workers exposed to normal construction-related risks. Workers at the treatment plant are exposed to work risks similar to those of chemical industry workers. Minor environmental impacts during construction, which can be mitigated. The short-term effectiveness of an alternative that combines Alternative SR1 with a subsequent Boulder Creek remedy would be similar to other action alternatives; substantial delay in implementing a Boulder Creek remedy would cause Alternative SR1 to be less effective in the short-term than the other action alternatives. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternative Study). Short-term impacts of those projects would likely be comparable to the SR1 projects because of the similarity in the nature of the problem being addressed and location.

VIII.6 Criterion 6—Implementability

Implementability refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution. It also includes coordination of Federal, State, and local governments to clean up the Site.

All the technologies are readily implementable. All the materials and work force necessary for each alternative are readily available. The administrative implementability for each alternative is straightforward and easy.

The No-Action Alternative, WM0, requires no additional effort and is readily implementable. The only aspect of this alternative that requires active implementation is the operation of existing facilities. The continued implementation of this alternative is straightforward.

The technical implementability of an enlargement of SCDD proposed in Alternatives WM1, WM2, and WM3 is relatively straightforward. All of the technologies and construction techniques for dam enlargement required for these alternatives are well understood. Construction sequencing will be carefully planned and phased to minimize environmental and construction hazards.

The treatment of the Slickrock Creek base flow in Alternatives WM2 and WM3 will require minor modifications to the construction of the HDS treatment facility. The modifications to the HDS treatment process are readily implementable because they involve only flow control, treatment, and existing sludge disposal facilities. All of these facilities involve well established technologies with known costs, effectiveness, and reliability.

Alternative WM3 would explore and secure options to guarantee the availability of water to ensure the dilution water for the uncontrolled spills from the existing SCDD through the purchase of necessary rights to the required amounts of water. These options include possible purchase of water from the CVP and from individual holders of water rights. Water right purchasing is a relatively new development in California; therefore, its implementability is uncertain.

Alternatives WM4 and SR1 propose standard construction and treatment processes, dam construction, and HDS treatment. The implementability of these alternatives is complicated by the difficult Site conditions, such as the narrow ravines and lack of relatively flat terrain. These Site features will complicate the design, construction, and maintenance of the dams, diversions, roads, pipelines, and treatment plant modifications. Operation of the treatment plant to treat all contaminated runoff during storms is expected to be difficult and challenging. The existing SCR provides a backup for episodic plant discharges of untreated waters. The Boulder Creek Remedial Alternatives Study indicates that response actions for Boulder Creek area sources would be implementable. The appropriateness and feasibility of responding to other sources (including but not limited to contaminated stream sediments) could be evaluated in a further remedial investigation and feasibility study, if necessary.

Table 7 below presents a comparison of each alternative's ability to meet this criterion.

TABLE 7
Summary of Implementability
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM0–No Further Action.	Readily implementable.
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	Readily implemented, as it uses well established technologies with known costs, effectiveness, and reliability. All materials and work force are readily available. Administrative implementability is straightforward.
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	Readily implemented, as it uses well established technologies with known costs, effectiveness, and reliability. All materials and work force are readily available. Administrative implementability is straightforward.

TABLE 7
Summary of Implementability
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Component
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	Readily implemented, as it uses well established technologies with known costs, effectiveness, and reliability. All materials and work force are readily available. Administrative implementability is straightforward. Securing of water rights is uncertain and may not be implementable.
Alternative WM4–Rely on the existing SCDD as backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	Readily implemented, as it uses well established technologies with known costs, effectiveness, and reliability. All materials and work force are readily available. Administrative implementability is straightforward. Site conditions will complicate the implementation of dams. Stormwater treatment may present operational difficulties.
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	Readily implemented, as it uses well established technologies with known costs, effectiveness, and reliability. All materials and work force are readily available. Administrative implementability is straightforward. Site conditions will complicate the implementation of dams. Stormwater treatment may present operational difficulties. Alternative SR1 can later be combined with an appropriate area source remedial alternative for Boulder Creek (such as those developed and evaluated in EPA's Boulder Creek Remedial Alternatives Study). The implementability of an alternative that combines SR1 with a subsequent Boulder Creek remedy would be similar. Implementability of other responses would be evaluated in subsequent investigations, if necessary.

VIII.7 Criterion 7—Cost

This criterion examines the estimated costs for each remedial alternative.

Table 8 below presents estimates of the 30-year present worth for each alternative. The table shows the initial capital investment, the initial annual operations and maintenance costs, the present worth of 30 years of operation (at 5 percent interest rate), and the total 30-year cost. The 30-year basis is selected to compare the costs of the alternatives, but remediation is expected to continue beyond 30 years.

TABLE 8
Summary of Cost
Record of Decision 1997, Iron Mountain Mine Superfund Site

Alternative	Total Capital Costs ($ x 1,000)	Total Annual O&M Costs ($ x 1,000)	Present Worth O&M Costs ($ x 1,000)	Total 30-Year Present Worth ($ x 1,000)
Alternative WM0–No Further Action.	0	0	0	0
Alternative WM1–Enlarge SCR to 15,000 acre-feet and dilute uncontrolled spill water, if dilution water is available.	74,240	60	922	75,162
Alternative WM2–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water, if dilution water is available.	77,531	273	4,196	81,727
Alternative WM3–Enlarge SCR to 15,000 acre-feet, collect and treat the base flow from Slickrock Creek, and dilute uncontrolled spill water with purchased dilution water.	77,531	899	13,816	91,347
Alternative WM4–Rely on the existing SCDD as backup for plant failures, build two alternative dams (one in Slickrock Creek and one in Boulder Creek), build clean-water diversions, and collect and treat all contaminated water.	116,215	928	14,271	130,486
Alternative SR1–Construct a dam in Slickrock Creek and clean-water diversions, collect and treat all contaminated Slickrock Creek runoff, and build a retaining structure for the hematite pile.	18,709	160	2,460	21,169
Most expensive Boulder Creek alternative developed to date	*30,374*	*320*	*4,920*	*35,294*
SR1 combined with most expensive Boulder Creek alternative developed to date	*49,083*	*480*	*7,380*	*56,943*

Alternative SR1 can later be combined with an area source remedial alternative for Boulder Creek. For purposes of cost comparisons between SR1 and other sitewide remedies, this analysis relies on Alternative No. 2H, Combined Area Source Alternative, as the appropriate

Boulder Creek remedy. That remedy is the most costly feasible alternative considered in the Boulder Creek Remedial Alternatives Study. Even when combined with the most expensive remedy for Boulder Creek area sources, Alternative SR1 provides the most cost-effective response to sitewide releases.

In general, these cost estimates are the product of the "order-of-magnitude" estimating procedures based upon conceptual layouts and preliminary cost information. Estimates of this nature are subject to changes as more detailed engineering and cost information becomes available. It is commonly assumed that actual cost may vary from the stated amounts by as much as +50 percent to -30 percent. Cost information for the enlargement of the SCDD would be significantly more reliable because of the more detailed studies conducted by EPA on that issue.

The costs shown for the alternatives do not include costs associated with future reliance on the existing SCDD to provide emergency storage during treatment plant failures or any other use of the existing SCDD. The cost of continued SCDD operations is comparable to the No-Action Alternative, which is assumed to have a cost of zero for purposes of the comparative analysis.

VIII.8 Criterion 8—State Acceptance

State acceptance refers to the State's position and key concerns related to the preferred alternative and other alternatives, and State comments on ARARs or the proposed use of waivers.

Throughout the development of this operable unit, EPA has worked closely with the California Department of Toxic Substances Control (DTSC) (the State lead agency), RWQCB, and CDFG. All three agencies support the selection of Alternative SR1 as described in the May 1996 Water Management FSA.

VIII.9 Criterion 9—Community Acceptance

This criterion refers to the community's stated preferences through oral and written comments on EPA's Proposed Plan regarding which components of the alternatives interested persons in the community support, have reservations about, or oppose.

There was significant community interest in EPA's June 1994 and May 1996 Proposed Plans. The public meeting held in connection with the May 1996 Proposed Plan was attended by approximately 25 people. The general public did not submit any comments on the May 1996 Proposed Plan, but comments submitted in connection with the May 1994 Proposed Plan expressed overwhelming support in favor of taking immediate action at the Site. In the context of the 1994 Proposed Plan, several community members supported onsite treatment in lieu of enlarging the SCDD. Prior comments from the community also supported the use of the inactive open pit mine, Brick Flat Pit, for sludge disposal.

Rhone-Poulenc submitted detailed comments in support of its conclusion that no further action is warranted at this time. If EPA selected additional response action, Rhone-Poulenc urged EPA to select treatment of Slickrock Creek baseflows. Rhone-Poulenc recently requested that EPA defer remedy selection to permit Rhone-Poulenc to investigate the feasibility and effectiveness of implementing limited surface-water collection in the Big Seep area of Slickrock Creek and a groundwater collection program that would rely on intercept trenches to collect limited groundwater from Slickrock Creek area sources.

IMMI did not submit any comments on EPA's 1996 Proposed Plan.

Responses to the above comments are presented in the Response to Comments document.

IX. THE SELECTED REMEDY

The EPA is selecting Alternative SR1 as described in the May 1996 Water Management FSA. The selected remedy incorporates a retention dam within the Slickrock Creek drainage, a clean water diversion system, and upgrades to the pipeline and treatment plant. The selected remedy relies on the collection and treatment of the AMD-contaminated surface-water discharges from the area sources in the Slickrock Creek watershed that discharge to the reach of Slickrock Creek below the heavily disturbed mining area. The remedy, as finally designed and implemented, may rely to some extent on source control of specific sources and on water management technologies to ensure collection of the contaminated surface flows as well as to minimize the amount of water that could become contaminated by the area source discharges and require treatment (such as a collection system for seeps under the hematite pile and the flows from Brick Flat Pit).

The major components of the selected remedy include:

- Construct a retention dam and necessary surface water diversion facilities to ensure the collection and storage of contaminated surface runoff, interflow, and groundwater in the Slickrock Creek watershed at IMM.

- Construct facilities to provide controlled release of contaminated waters from the retention dam to the AMD conveyance pipeline to the IMM HDS/ASM lime neutralization treatment plant.

- Construct facilities to divert relatively uncontaminated surface water from the area upstream from the highly disturbed mining area of the Slickrock Creek basin and divert that water around the Slickrock Creek retention reservoir. The diversion shall also divert around the retention reservoir the water from the unmined side of the Slickrock Creek watershed.

- Take appropriate steps (including consideration of emergency failure scenarios) to integrate into the operation of the reservoir the collection and conveyance of the Old/No. 8 Mine Seep AMD to the IMM HDS/ASM lime neutralization treatment plant.

- Construct a hematite erosion control structure consistent with California mining waste requirements.

- Construct one or more sedimentation basin(s) or other EPA approved control structures in the Slickrock Creek watershed to minimize sedimentation of the Slickrock Creek retention reservoir and to ensure proper functioning of the controlled release facilities.

- Upgrade the hydraulic capacity of the existing pipeline (or if necessary construct a new pipeline) from Slickrock Creek to the Boulder Creek crossing as required to ensure adequate reliable capacity to convey Slickrock Creek and Old/No. 8 Mine Seep AMD.

- Construct an additional pipeline to reliably convey Slickrock Creek and Old/No. 8 Mine Seep AMD from the Boulder Creek Crossing to the IMM HDS/ASM lime neutralization treatment plant.

- Modify the IMM HDS/ASM lime neutralization treatment plant to ensure proper treatment, using the HDS/ASM treatment process, of the Slickrock Creek area source AMD discharges in conjunction with AMD flows collected pursuant to other Records of Decision.

- Construct a tunnel to provide for gravity discharge of the high volumes of effluent from the IMM HDS/ASM treatment plant to Spring Creek below the Upper Spring Creek diversion to Flat Creek.

- Construct facilities to assure collection of significant identified sources (including but not limited to seeps from Brick Flat Pit and the hematite piles) and convey those releases to the Slickrock Creek Retention Reservoir.

- Perform long-term operations and maintenance (O&M) of all components.

X. STATUTORY DETERMINATIONS

The EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action for the Site comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted for a particular ARAR. The selected remedy must also use permanent treatment technologies or resource recovery technologies to the maximum extent practicable and be cost-effective. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy meets these statutory requirements.

X.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment from the exposure pathways that are being addressed in this interim action. The selected remedy addresses IMM AMD releases from essentially all of Slickrock Creek area sources and the hematite pile. The alternative will permit treatment of essentially all of the IMM AMD from the Slickrock Creek area sources, which comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium releases from IMM. These collected releases will be treated to neutralize the acidity of the water and remove more than 99 percent of the metals. The concentrations in the contaminated Spring Creek watershed would be expected to decrease proportionately under all hydrologic conditions. The remedy will also control releases from the hematite pile. The selected remedy is an interim remedy that is not expected to be final and does not address all of the sources of discharges from the Site. The selected remedy therefore cannot be expected to be fully protective of human health and the environment.

The primary human health-related exposure pathway is the ingestion of contaminated surface waters. The selected remedy would ensure that State and Federal drinking water standards are not exceeded at the point of withdrawal for the Redding Municipal Water District, except during extreme spill events. The alternative will improve water quality in the creeks draining Iron Mountain, in SCR, and in the lower portion of Keswick Reservoir, but the remedy will not ensure compliance with human health standards in these water bodies. The human health threat posed by potential exposure to contaminated sediments through ingestion is not addressed by the selected remedy. However, control of the hematite pile will reduce the release of airborne arsenic into the environment.

The environmental threats posed by these sources are the very significant releases of copper, cadmium, zinc, and acidity into surface waters. The selected remedy will essentially eliminate the discharges from the sources being addressed in this interim action. The removal of these metal loads associated with the Slickrock Creek area sources will significantly improve the surface water quality below the SCDD and provide significant protection to aquatic resources below Keswick Dam. The metal removal will decrease the frequency, duration, and toxicity of SCDD spills of IMM AMD, make significant progress toward the attainment of appropriate water quality criteria in and below Keswick Reservoir, and provide some improvement in receiving waters above the SCDD.

The removal of metals will make significant progress toward compliance with the SBPS and the PCTR in the Spring Creek arm of the Keswick Reservoir. Currently, water quality criteria in that water body are exceeded on a regular basis, and only limited beneficial uses are attainable under current conditions.

The anticipated reduction in SCDD spill frequency associated with the selected remedy is not as great as Alternatives WM1, WM2, WM3, and WM4; however, the spills occurring after implementation of the selected remedy will tend to be less toxic and require less dilution because the SCR water will contain lower concentrations of metals. When combined with a remedy for the Boulder Creek area sources (to be the subject of additional study and a later EPA decision), the selected remedy could potentially be comparable to the other alternatives with respect to reducing SCDD spills and protecting the environment below SCDD.

The current uncontrolled IMM area source AMD discharges are estimated to result in SCR waters with copper concentrations of approximately 400 to 800 ppb, and zinc concentrations of approximately 600 to 1,200 ppb. The selected remedy is expected to decrease the SCR water concentrations in proportion to the load reduction to approximately 150 to 250 ppb copper and 300 to 600 ppb zinc (with similar proportional reductions for cadmium). Although less polluted than current conditions, these levels will remain well in excess of the existing standards for copper (5.6 ppb) and zinc (16 ppb). Since the water will be less contaminated, the water will require less dilution to meet protective standards, so the SCR waters could generally be discharged from the SCR under controlled conditions at higher rates than the current discharge. The ability to discharge greater quantities of water creates a greater capacity to manage the discharge of the large flows of contaminated stormwaters. This greater water management capability reduces the frequency of uncontrolled spills from SCDD, which in turn reduces the frequency of SBPS and PCTR exceedances below Keswick Dam.

Water quality modeling using the most recently acquired data indicates that the selected remedy will provide significant additional protection to the environment. The model takes into account all the remedial actions implemented to date and calculates the frequency at which the SBPS and the PCTR would be exceeded in the main stem of the Sacramento River below Keswick Dam over the 31-year study period (1965 to 1995). The model is capable of taking into account the uncertainties inherent in real-time operation of CVP facilities. For the modeling conducted in 1996, EPA generally assumed that these uncertainties could be accounted for by targeting SCDD operations to meet a value equal to 75 percent of the actual standard. Comments submitted by the USBR indicate that this assumption might be overly optimistic, which would cause the model to understate the frequency and duration of exceedances. Since 1996, EPA has conducted additional analysis of the difficulties inherent in trying to predict metal concentrations below the SCDD in real-time under highly variable conditions. This additional investigation indicates that, even if significant resources are expended to perform an intensive monitoring program and make frequent operational adjustments, achieving a 75 percent SCDD operational efficiency under all conditions could be an overly optimistic assumption. EPA therefore considers a range of operational efficiencies in evaluating the probability of future SCDD spills under variable hydrologic conditions, including a strait 75 percent assumption and a split operational efficiency that varies the assumed efficiency from 50 to 75 percent depending on the SCR inflows (75 percent is used for SCR inflows less than 50 cfs and 50 percent is used for SCR inflows greater than 50 cfs).

Considering concentration and flow information developed since 1994 and a range of SCDD operation efficiencies indicates that, in the absence of further remediation, uncontrolled spills of IMM contaminants would continue to occur every 3 to 4 years if the SCR is operated to target the SBPS below Keswick Dam and every 2 to 3 years if the SCR is operated to target the PCTR below Keswick Dam. Implementing Alternative SR1 would reduce the expected SCDD spill frequency to once every 8 to 10 years if the SCR is operated to target the SBPS below Keswick Dam and every 4 to 8 years if the SCR is operated to target the PCTR below Keswick Dam. Alternative SR1 is also expected to decrease by approximately 80 percent the days that the Sacramento River below Keswick Dam experiences a violation of a water quality criteria. See responses to comments in the technical memorandum responding to the *Evaluation of Revised IMM Water Quality Model and its Application to Slickrock Creek Remediation*, by Spaulding Environmental, dated July 1, 1996 and *Additional Water Quality Model Simulations Using Data Collected Through June 1997 and Proposed Water Quality Standards*. The Alternative is also expected to improve water quality in Keswick Reservoir, part of which currently experiences exceedances of the SBPS and PCTR for much of each wet season.

The selected remedy would also protect the environment by significantly reducing the mass loads of copper, cadmium, and zinc through removal of approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium Site discharges. The release of these metals causes heavy metal precipitates to form in the water column, some of which settle in the SCAKR and the Sacramento River below Keswick Dam. The heavy metal-laden precipitates threaten the environment through the physical processes of settling, which could smother benthic organisms, and the inherent toxicity of the heavy metal-laden sediments and the associated pore water (i.e., water in the space in between sediment particles) to benthic organisms. These releases also interfere with remediation of the heavy metal-laden sediments currently in place in SCAKR and other State waters (by continuing the introduction of new sediments on a regular basis). Remediation of these sediments could allow for the restoration of beneficial uses for the affected water bodies which would eliminate the threat of releases of toxic metals through mobilization of the sediments.

The selected remedy also protects the environment from the releases being addressed by improving water quality in Spring Creek and Slickrock Creek. While it is too early to determine the extent to which beneficial uses could be fully restored to those waters, removal of these significant metal loads is anticipated to improve the beneficial uses of these impaired waters. Since this is an interim remedy that does not control all releases, however, EPA does not expect that this action will be capable of restoring all beneficial uses to those water bodies.

Reducing metal loads from IMM also produces ancillary environmental benefits by reducing the need for special dilution releases. For example, if special releases of water are required for dilution of IMM AMD, those releases reduce the amounts of water in storage that would otherwise be available for temperature control in the Sacramento River or other environmental needs. An additional ancillary benefit can be realized with reduced reliance on the current use of the Spring Creek Power House discharges to ensure regular flushing of the heavy metals from SCAKR (as described in the USBR Operation Criteria and Plan 1993, pages 44 and 45). Demand for water from the Trinity River and upper Clear Creek would be reduced, increasing its availability for beneficial uses in those watersheds.

As part of the Site investigation, EPA has concluded that Site remedies that rely on the selected remedy as a component are feasible, and can ensure that releases associated with an extreme hydrologic event would be rare.

In summary, current conditions are not protective and do not meet the remedial action objectives for the Site. The implementation of the Slickrock Creek Retention Dam remedial action is not expected to fully meet the remedial action objectives for the Site without further actions, but would significantly reduce the exceedances of the water quality standards and production of toxic sediments. These beneficial effects are expected to significantly improve the protectiveness of the Superfund cleanup.

With respect to this criterion, the selected remedy, in conjunction with a subsequent Boulder Creek remedy, is preferable to Alternatives WM0, WM1, WM2, and WM3. The remedy, which can easily be implemented in conjunction with a Boulder Creek remedy, would remove a significant amount of heavy metals from the system rather than simply diluting the heavy metal discharges or treating only the Slickrock Creek baseflows. Alternative SR1, in conjunction with an available Boulder Creek remedy, could provide protection approximately equivalent to Alternative WM4, but at less cost.

X.2 Compliance with ARARs

The selected remedy provides for significant progress toward meeting ARARs for the Superfund cleanup action at IMM by reducing the discharges of copper, cadmium, zinc, and acidity from the Site. In particular, the remedy will result in better water quality in the Sacramento River by limiting discharges of copper, cadmium, zinc, and acidity from the Site, thereby reducing the number of days and/or the degree of exceedances of the State Basin Plan standards (and the PCTR) in the Sacramento River and Keswick Reservoir. This section discusses the ARARs which the action will meet and identifies the ARARs which are being waived.

The Slickrock Creek area discharges are similar in nature and characteristics to the IMM AMD sources addressed in the September 30, 1992, Record of Decision for the Boulder Creek Operable Unit at IMM. The September 30, 1992, Record of Decision thoroughly discusses the ARARs for this type of source (AMD containing high concentrations of copper, cadmium, and zinc) and ARARs for the selected remedy (treatment with onsite sludge disposal or discharge of the treated effluent to lower Spring Creek and waste pile management). The September 30, 1992, Record of Decision discussion regarding ARARs in Section X.2 is incorporated fully by reference, except as modified below.

Compliance with Chemical-Specific ARARs

The selected remedy makes significant progress toward complying with chemical-specific ARARs below Keswick Dam, but the remedy does not ensure compliance with the SBPS under all circumstances and in all locations. The reduction in the IMM metal discharges would significantly increase compliance with the SBPS in the Sacramento River except in unusual circumstances. The treatment plant will continue to meet the effluent standards as set forth in the 1992 ROD.

The selected remedy would improve water quality in Keswick Reservoir but would not assure compliance with the SBPS under all circumstances. Combining the selected remedy with an available Boulder Creek Remedy could potentially attain compliance with the ARARs for Keswick Reservoir.

In the 1992 ROD, EPA identified the California Inland Surface Waters Plan as an ARAR. Since that time, the plan has been held to be invalid on procedural grounds, so the standards are not ARARs for this response action. Once the plan was invalidated, California no longer had statewide numeric water quality criteria. On August 5, 1997, EPA promulgated the PCTR, which are draft statewide water quality criteria for California (62 Federal Register 42160 [1997]). If adopted, the standards would apply to subsequent response actions at IMM to the extent the standards are more stringent than the SBPS. Because the SBPS do not currently have a 96-hour standard (the SBPS are stated as instantaneous maximums), the PCTR would likely serve as that standard. As discussed above, the selected remedy will make significant progress toward enabling management of Site discharges in a manner that would comply with the PCTR.

The selected remedy does not ensure compliance with the SBPS or PCTR above the SCDD, and continuous exceedances in those bodies are expected to remain even after implementation of Alternative SR1. Since Alternative SR1 removes significant metal loads from Slickrock Creek, some of the beneficial uses of that stream could potentially be restored over time (particularly if additional steps are taken to address the remaining sources in that watershed).

The disposal of sludge from the treatment effluent would be required to meet State standards applicable to mining waste. Sludge from treatment of the Slickrock Creek contaminated waters would be disposed of in the onsite landfill constructed pursuant to ROD2 and ROD3. The disposal facility was constructed in accordance with the State standards for disposal of mining wastes.

Compliance with Location-Specific ARARs

The selected remedy shall address and comply with all location-specific ARARs. Significant action-specific ARARs include those relating to disposal of treatment sludge and ARARs directing activity to protect affected fisheries, aquatic resources and their habitat.

The action would need to comply with the substantive requirements of the Fish and Wildlife Coordination Act because the action will result in the regular inundation of an area on the mine property. Areas that would be unavoidably impacted by the selected remedy include chaparral and riparian habitat that is currently significantly impaired because the area is highly disturbed by past mining activity. The EPA will consult with the USFWS to develop appropriate mitigation measures.

The requirements for protection of habitat in the Endangered Species Act are also ARARs for this action. The selected remedy would have a potential impact on a federally endangered species because the action would reduce the toxic releases from IMM that threaten the winter-run chinook salmon. Although it is anticipated that such impacts will be beneficial and would further the goals of the Endangered Species Act, EPA has been consulting with the NMFS in accordance with the provisions of the Endangered Species Act. The EPA has also worked closely with the appropriate Natural Resource Trustees to ensure protection of natural resources.

This action will not impact archaeological and/or historic sites of significance.

Compliance with Action-Specific ARARs

The selected remedy shall address and is expected to comply with all action-specific ARARs. The action would have a potential impact on a federally endangered species. Although it is anticipated that such impacts would be beneficial, EPA has been coordinating the development and evaluation of potential IMM remedial actions with the Federal and State Natural Resource Trustees. Consistent with the provisions of the Endangered Species Act, EPA has been consulting with the NMFS regarding proposed remedial actions for the Site.

In prior actions, the State of California has identified State requirements for seismic safety as requirements for construction projects generally (see CDFG letter of March 27, 1992). The Dam Safety Act also serves as an ARAR for the construction of any dam, including the dam to be constructed as part of this response action. (See DTSC and RWQCB letter of March 30, 1992).

The selected remedy involves control of the large hematite pile located in the Slickrock Creek watershed. The inactive mining waste unit shall be controlled in the manner required by the California Mining Waste Requirements identified in the 1992 ROD.

ARAR Waivers

The EPA is waiving compliance with certain ARARs on the basis that this proposed action is an interim action that will not respond to all releases of hazardous substances from the facility. Since the dam and treat interim remedial action for the Slickrock Creek area source AMD discharges does not address releases other than area sources discharging to the reach of Slickrock Creek below the heavily disturbed mining area, such as releases from area sources in the Boulder Creek watershed and the existing sediments in SCR and Keswick Reservoir, this interim action is not expected to provide for compliance with all ARARs at all times. Since the action selected in this Record of Decision is an interim action that leaves some releases of hazardous substances unabated, EPA is relying on the ARARs waiver for "interim measures" (CERCLA § 121(d)(4)(A); 40 CFR § 300.430(f)(1)(ii)(C)(1)) for this remedial action. That section provides that ARARs may be waived if "the remedial action selected is only part of a total remediation that will attain such level or standards of control when completed."

The EPA anticipates that the remedy will improve water quality in Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River, but EPA does not anticipate that this remedy, in conjunction the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific standards contained in the SBPS for copper, cadmium, or zinc, and (2) California Fish and Game Code § 5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards for the interim action to the extent those standards cannot be achieved by the remedy selected in this Record of Decision in conjunction with the remedies implemented under prior RODs.

The EPA anticipates that a permanent waiver for certain ARARs might ultimately be required for certain receiving waters above the SCDD, but EPA is deferring a final decision until additional information is known regarding the feasibility and degree to which some beneficial uses could be restored to those water bodies.

X.3 Cost-Effectiveness

Section 300.430(f)(1)(ii)(D) of the NCP requires EPA to evaluate cost-effectiveness by comparing the alternatives that meet the threshold criteria against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. The selected remedy is cost-effective with respect to meeting these criteria.

The total cost of the selected remedy (including both the capital and O&M costs based on a 30-year present worth cost using a 5 percent interest rate) is estimated to be about $21,169,000. Since EPA has not yet addressed further Boulder Creek remedial actions or continued SCDD operations as part of the selected remedy, the costs described above for implementation of the selected remedy do not include the expected costs associated with potential remedies for the Boulder Creek area sources or continued operation of SCDD.

To more fully evaluate the cost-effectiveness of the selected remedy, EPA considered the cost of combining the selected remedy with the most expensive technically feasible Boulder Creek remedy from EPA's Boulder Creek Alternatives Study (which is referred to below as the Combined Alternative SR1). The 30-year present worth cost of the Combined Alternative SR1 is estimated to be less than $57 million. (EPA is still investigating the appropriate response action for Boulder Creek area sources, so the response action for those sources could be greater or less than the amount used in this analysis.) The Combined Alternative SR1 is less costly than the other remedial alternatives, which range in cost from approximately $75 million to approximately $130 million. As discussed above, this combined remedy would provide a response action that is at least equivalent to the other remedies with respect to (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, or volume through treatment; and (3) short-term effectiveness. The selected remedy is therefore a cost-effective component of the overall response action.

The cost estimates for these alternatives do not include the cost of continuing to operate the SCDD as a component of the remedies because the cost of continued SCDD operations is comparable to the No-Action Alternative, which is assumed to have a cost of zero for purposes of the comparative analysis.

X.4 Utilization of Permanent Solutions and Alternative Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be employed in a cost-effective manner for the interim remedial action.

The EPA recognizes that the mineralization at IMM will continue to generate AMD unless additional remedial actions are developed, evaluated, and selected for implementation to reduce or eliminate the AMD-forming reactions. The EPA has developed and evaluated alternatives as part of the ongoing remedial investigation and feasibility study activities at IMM that could reduce or eliminate the AMD-forming reactions. Resource recovery alternatives have also been proposed and evaluated. The EPA has concluded that further information is required to be developed and evaluated before one of these approaches could be selected for implementation. The needed further information would address technical feasibility, implementability, effectiveness, and cost-effectiveness concerns and risk factors with respect to these approaches. The EPA encourages the further development of alternatives that could control the AMD-forming reactions and resource recovery alternatives for future evaluation and potential selection in a subsequent action.

The selected remedy will provide for a significant reduction in the copper, cadmium, zinc, and acidity discharges from the Site. The current water supply and fishery conditions are critical. There is a need to implement controls on these discharges as expeditiously as possible, while studies are ongoing with respect to further source control or resource recovery approaches. Treatment is effective, a part of each approach developed to date, and is consistent with implementation of a subsequent action.

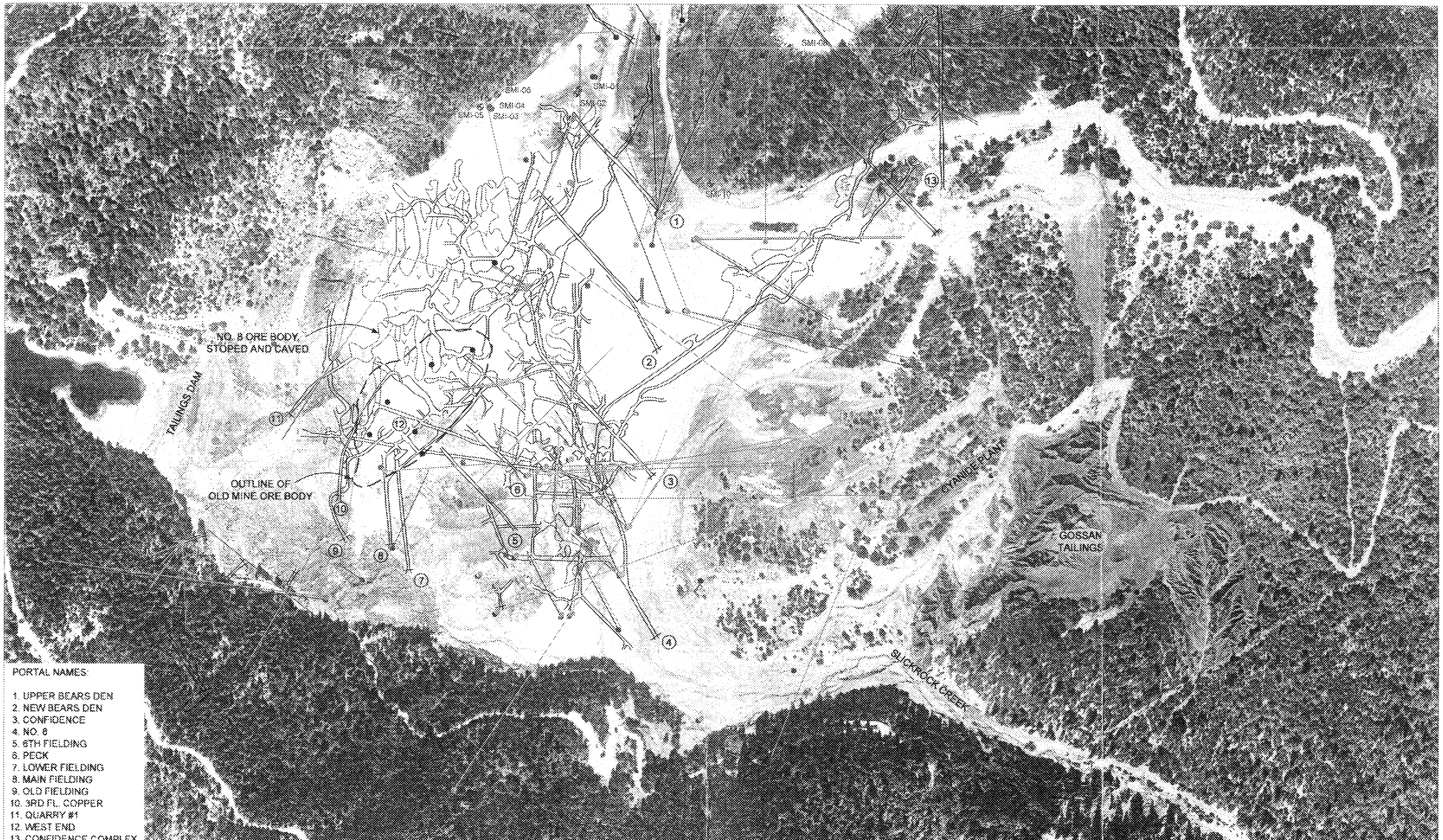
X.5 Preference for Treatment as a Principal Element

The selected remedy relies on treatment as a primary component to reduce the toxicity and mobility of the AMD which is being generated. The HDS neutralization treatment process is expected to be very effective in preventing the discharge of metals from the Slickrock Creek contaminated flows that are collected and conveyed to the treatment plant for treatment. The HDS neutralization process is expected to remove more than 99 percent of the metals from the treated contaminated Slickrock Creek flows.

The EPA is not selecting a remedy that treats the source in a manner that prevents the formation of AMD because EPA is not currently aware of such an approach that could be effectively implemented at IMM. The EPA encourages the continued development and evaluation of alternatives that may partially satisfy the preference for treatment as a principal element, and this issue will be addressed in the final decision document for the Site. The EPA has concluded that further development and evaluation of the above approaches is necessary to address significant uncertainties with respect to technical feasibility, implementability, effectiveness, cost-effectiveness concerns, and risk factors.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The EPA is today approving the Proposed Plan with no significant changes.



PORTAL NAMES:

1. UPPER BEARS DEN
2. NEW BEARS DEN
3. CONFIDENCE
4. NO. 8
5. 6TH FIELDING
6. PECK
7. LOWER FIELDING
8. MAIN FIELDING
9. OLD FIELDING
10. 3RD FL. COPPER
11. QUARRY #1
12. WEST END
13. CONFIDENCE COMPLEX

DRILL HOLES:
- 1959 MT. COPPER CO. BRICK FLAT DIAMOND DRILL MAP (CH0289)
- 1983 RUSKIN DEVELOPMENTS LTD IRON MT. MINE DRILL HOLE MAP (CH0061-04)
- 1912 GENERAL SURVEY OF IRON MT. MINE FOR THE MT. COPPER CO. (CH0052-01)
- 1914 TABULATION OF DIAMOND DRILL HOLES (RIC 0353)

SMI WELLS (SHEPARD MILLER, 1996)
CAVED ADIT AND WORKINGS
ORE BODIES
LIMIT OF STOPING

LOCATION OF ORE BODIES AND WORKINGS ESTIMATED FROM KINKEL, HALL AND ALBERS GEOLOGICAL SURVEY PAPER 285 PLATE 8 U.S. DEPARTMENT OF INTERIOR.

PHOTOGRAPHY DATED 9-3-68
DIGITAL ORTHOPHOTO MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1" = 300' SCALE

0 100 200 300
FEET

N

PHOTO EXHIBIT 1
MINE WORKINGS & DRILL HOLES
SLICKROCK CREEK

IRON MOUNTAIN MINE, REDDING, CALIFORNIA

SRB8701.DGN-SRB07.TIF

SR8706.DCIN-SRRO2.TIF

APPROXIMATE AREA COLLECTED FOR TREATMENT
APPROXIMATE AREA NOT COLLECTED FOR TREATMENT

PHOTOGRAPHY DATED 9-3-68
DIGITAL ORTHOPHOTO MEETS NATIONAL
MAP ACCURACY STANDARDS FOR 1" = 300' SCALE

0 100 200 300
FEET

N

PHOTO EXHIBIT 2
CONCEPTUAL DEPICTION OF SELECTED REMEDY
SLICKROCK CREEK AREA SOURCES

IRON MOUNTAIN MINE, REDDING, CALIFORNIA

RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECLARATION

I. SITE NAME AND LOCATION

Iron Mountain Mine (IMM)
Shasta County, California (approximately 9 miles northwest of Redding, California)

II. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial action for control of releases of hazardous substances from widespread area sources in the Slickrock Creek watershed at the Iron Mountain Mine Site. The selected interim remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based upon the Administrative Record for this Site.

The State of California concurs with the selected interim remedial action for the Slickrock Creek area source acid mine drainage (AMD) discharges at the Iron Mountain Mine Superfund Site.

III. ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

The Slickrock Creek area sources of AMD include the numerous waste piles on the mine property, disturbed areas related to mining activity, contaminated groundwater and interflow seepage, underground mine workings, and underground mineralization exposed through mining-induced hydrologic and physical changes. The general disturbances in this area of Slickrock Creek are shown in Photo Exhibit 1. The releases from these sources consist of highly acidic, heavy metal-bearing waters, termed acid mine drainage, or AMD. The heavy metals contained in the AMD from Slickrock Creek area sources include, among others, copper, cadmium, and zinc. The AMD contains acidity and concentrations of copper, cadmium, and zinc that are toxic to aquatic life and harmful to humans. The response action will also address the hematite mine waste piles, which contain high levels of arsenic and are actively eroding into Slickrock Creek and thence to downstream areas.

The principal threat posed by these releases is the creation of conditions toxic to aquatic life in the receiving waters downstream of the Site. Surface water is the primary exposure path-

MAIL CODE	SFD-7-2	ORC-3	RC-3	SFD-7	SFD-7-2	
SURNAME	RSap	Bloomfield	[illegible]	Kemmerer	KMoore	
DATE	9/30/97	9/30/97	9/30/97	9/30/97	9/30/97	

1652-04373

Redding Office

2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: Department of Fish and Game
601 Locust Street
Redding, CA 96001

DATE: October 24, 1997

RE: Iron Mountain Mine

ATTEN: Ms. Jane Vorpagal

PROJECT NO.: 137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [X] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [ ] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (lt)
Site Manager

CH2M HILL

Redding Office
2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: National Marine Fisheries Service
1305 East-West Highway, Room 10337
Silver Spring, Maryland 20910

Phone: 301/713-3038

ATTEN: Mr. Norman Meade

DATE: October 24, 1997

RE: Iron Mountain Mine

PROJECT NO.: 137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [ ] HERREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [x] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (lt)
Site Manager

CH2M HILL

Redding Office

2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: National Marine Fisheries Service
525 NE Oregon Street, Suite 500
Portland, OR 97232

Phone: 503/230-5428

ATTEN: Mr. Nick Iadanza

DATE: October 24, 1997

RE: Iron Mountain Mine

PROJECT NO.: 137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [ ] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [x] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (1t)
Site Manager

Redding Office

CH2M HILL
2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: BLM RS130
Denver Federal Center Building 50
Lakewood, Colorado 80225

Phone: 303/236-8858

ATTEN: Mr. Paul Meyer

DATE: October 24, 1997

RE: Iron Mountain Mine

PROJECT NO.: 137295.01.01 ;10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [ ] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [X] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (II)
Site Manager

CH2M HILL

Redding Office

2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: Breidenbach, Buckley, Huchting, Halm & Hamblet
611 West Sixth Street, 13th Floor
Los Angeles, CA 90017-3100
Phone: 213/624-3431

ATTEN: Ms. Suzanne Henderson

DATE: October 24, 1997

RE: Iron Mountain Mine

PROJECT NO.: 137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [ ] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [x] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (li)
Site Manager

Redding Office
2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO:	Department of Fish and Game	**DATE:**	October 24, 1997
	13th Floor	**RE:**	Iron Mountain Mine
	1416 9th Street		
	Sacramento, CA 95814		
	Phone: 916/654-3830		
ATTEN:	Ms. Jenny Decker	**PROJECT NO.:**	137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [X] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [ ] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (lt)
Site Manager

CH2M HILL

Redding Office

2525 Airpark Drive, Redding, California 96049, Telephone:916/243-5831

TO: Jim Stefanoff/SPK
Jim Schneider/DEN
Roger Lindquist/CVO

ATTEN:

DATE: October 24, 1997

RE: Iron Mountain Mine

PROJECT NO.: 137295.01.01 10/24/97

WE ARE SENDING THE FOLLOWING MATERIAL TO YOU

- [ ] HEREWITH
- [ ] GREYHOUND
- [ ] FIRST CLASS MAIL
- [x] EXPRESS
- [ ] UPS
- [ ] OTHER

QUANTITY	ITEM
1	Enclosed is a copy of the September 30, 1997, Record of Decision
	(ROD4) for the Iron Mountain Mine Site.

COPIES: File
Rick Sugarek/U.S. EPA Region IX

BY: John Spitzley (lt)
Site Manager